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Doctorate in Architectural Design, Theory and Technology
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THE PERFORATED BUILDING'S ENVELOPE: GUIDING THE EARLY DESIGN PHASES

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CYCLE XXIX
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DEDICATION

This challenging work needed an eternal strong will, as well as a very strong outstanding support. Therefore, I dedicate this work to my ever supporters: my fabulous father, my great wife and sweet sons, my brothers and sisters, my extended family, my friends in Palestine, Jordan, Iraq, Lebanon, Egypt, Libya, Tunisia, Algeria, Italy, and in the other countries. I dedicate this work to my wonderful tutors and my colleagues at University of Palermo. Furthermore, I dedicate this work to the spiritual supporter, my mother, who has the greatest role of support through all my previous challenges in life.

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Finally, I thank everybody who has any role in developing this work.

*«Thirty spokes share the wheel's hub; It is the centre hole that makes it useful.
Shape clay into a vessel; It is the space within that makes it useful.
Cut doors and windows for a room; It is the holes which make it useful.
Therefore profit comes from what is there; Usefulness from what is not there».
[Tao Te Ching -Lao Tzu - chapter 11].*

"Architecture is the learned game, correct and magnificent, of forms assembled in the light". This famous phrase by Le Corbusier couldn't be expressive without the existence of voids/spaces between forms. The architectural forms are revealed by the "light and shade", deriving a certain sense of the relationships between solid and void. Nevertheless, the general architectural attention is mostly focused on the materials, with a certain negligence to what happens within the voids.

The void is more than a 'negative' effect that formally features the architecture. The void is paradoxically full of elements those deeply influence the quality of the built environment: the fresh air for healthy breathe which in turns conveys the solar heat; and the essential healthy natural light. But also our socio-cultural relationships with the external environment those are woven through the voids of the building's envelope, making us feel threatened or shielded, bothered or reassured, veiled and revealed. The architectural void, ultimately, is more than a physical status and it is featured by both the quantitative and qualitative aspects.

This PhD thesis has focused on both the "solid" and the "void" components of the perforated building's envelope, where the researcher has pinpointed some important links between the traditional architecture of the Middle East and the Mediterranean region, and –above all– the significant and the globally widespread trend in the contemporary architecture that it is important to be addressed towards a more conscious and responsible architectural design.

The solid components of perforated building's envelope can be referred to the building materials (concrete, bricks, stone, ceramic, metal, plastic, wood, reeds) and to the different general or detail design solutions (single or several perforated layers; perforated layer thickness, dynamism techniques). The void component of the perforated building's envelope can be referred to the perforation pattern shape, the perforation sizing and ratios, the perforation configuration, and the air cavity parameters (in the double skin envelopes).

The learned game of solid and void in a perforated facade reproduces, in a detailed scale, the learned game of volumes and forms that is indicated by Le Corbusier as an essential basis for Architecture, but this new learned game doesn't produce only the formative consequences, but also the environmental performances those affect the behaviour and the habits of the building's users, on both of the individual and the community levels.

The contemporary challenges in Architectural Design need to be faced through managing properly the technological tools, avoiding any separating between the physical form and the environment, paying attention to the material and immaterial features of the built environment, and obtaining the usefulness from the inexistent: the void.

ABSTRACT

Perforation of building envelope is historically connected -in some circumstances- to the traditional architectural models (i.e. the ‘Mashrabiyya’) that consist of archetypical perforated elements to play technological, environmental, socio-cultural, or economic roles, reflecting the community values, its economic situation, and the occupants’ environmental needs. Nowadays, the perforation of building envelope presents a global contemporary architectural trend, which had a greater emergence since the beginnings of the 21st century, following the emergence of the digital technology that led to the development of the construction techniques, materials, implementations, buildings performance and appearance, etc.

The research significance relies on the need to develop a holistic guide for designing this type of perforated building envelope, as there is no evident process for guiding at least the early design phases. The few recent related types of research are mostly discussing specific environmental issues of the perforated envelopes and neglecting the consideration of socio-cultural, the economic, and the technological aspects altogether alongside the environmental ones. For this reason, and due to the importance of guiding this rising trend, the research aims at extracting some general guidelines that can be followed and considered by architects and architecture students in the early design phases of perforated envelopes, in the future.

The guidelines extraction process depends on analyzing a selected representative sample of contemporary cases of perforated building envelope, taking the technological, environmental, socio-cultural, and economic indicators into consideration for conducting and constructing the analytical model which has been adopted after certain testing and validation processes. The holistic analysis has led to the extraction of sixty general guidelines, those have been developed by constructing a specific questionnaire to evaluate them by different experts who have related design work, and also by some researchers those have published related scientific works.

As a vision for the future related work, a contextual appropriateness of the guidelines can be studied in order to specifically integrate and interrelate them in the design solutions by considering a specific community circumstances and specific climatic parameters.

Keywords: contemporary perforated envelopes, traditional perforations, early design phases, guidelines.

ABSTRACT

In passato gli involucri edilizi perforati sono stati talvolta ricondotti ad alcuni elementi architettonici tradizionali (come, ad esempio, la 'Mashrabiyya'), in cui gli elementi forati acquisiscono quasi significati archetipici, nell'assumere ruoli tecnologici e ambientali che rispecchiano i valori della comunità, le condizioni socio-economiche e le esigenze ambientali degli occupanti. Oggi, invece, l'involucro edilizio perforato costituisce una tendenza architettonica che ha iniziato a manifestarsi a livello globale all'inizio del nuovo millennio, alla quale ha contribuito l'emergere della tecnologia digitale con i suoi effetti sull'innovazione di tecniche, materiali, realizzazioni, prestazioni e aspetto degli edifici.

La presente tesi dottorale ha preso spunto dal fatto che manca qualunque forma di guida generale per la progettazione di questo tipo di involucro. I pochi studi dedicati specificatamente all'involucro perforato principalmente ne discutono aspetti ambientali, trascurando quelli socio-culturali, economici e tecnologici. Considerando utile offrire un riferimento alla crescente diffusione di soluzioni perforate per gli involucri edilizi, la ricerca ha proposto una serie di linee guida di carattere generale, da mettere a disposizione di architetti o studenti di architettura, da utilizzare sin dalle prime fasi della progettazione.

Sessanta linee guida generali sono state ricavate dall'analisi di un campione rappresentativo di esempi, selezionati tra gli edifici contemporanei che presentano involucri perforati. Tale analisi è stata svolta applicando un insieme di indicatori (tecnologici, ambientali, socio-culturali ed economici) sui quali si è basata la metodologia analitica. Le linee guida, così ricavate attraverso un percorso di sistematizzazione e sintesi, sono state poi messe alla prova, sottoponendole a un processo di validazione da parte di studiosi e professionisti utilizzando schede e questionari.

Gli sviluppi futuri di questo studio si incentreranno sulla verifica della specifica appropriatezza contestuale, anche attraverso la redazione di linee guida riferita a scala ridotta, al fine di integrare le soluzioni progettuali in particolare con i valori della comunità e le esigenze climatiche locali.

Parole chiave: involucri perforati contemporanei, perforazione tradizionale, prima fase progettazione, linee guida.

CONTENTS

INTRODUCTION

Background

Maintaining the architectural identity, controlling the energy consumption, and facing the environmental and socio-economic problems have recently become a significant global challenge. For this reason, the all architects have to take their actual role in integrating the climatic considerations, the local community circumstances, and the new technologies together to enhance the quality of the built-up environments. The design process has become, sometimes, as a sort of fashion by imitating or copying the architectural elements, without any innovation or valuable contribution, or without any regard to the features of the local context. The significant contribution comes from those architects who are developing innovative solutions to improve the present and the future built-up environments.

The number of architects and researchers those care about producing sustainable built-up environments is globally increasing as the sustainable architectural design is considered as one of the important tools for treating a large number of environmental problems those have emerged increasingly since the last century, or before. Those problems include the environment pollution, disruption of the ecosystem, depletion of natural recourses, global warming, desertification, etc. The recent calls are focusing on the adoption of green values, sustainable designs, the use of renewable energy, and reconsidering the relationship between man and environment to produce healthy and comfortable living sphere and to save the ecosystem.

It is critical to design the buildings without understanding their relationship to the local context, it is also impossible to protect the natural environment without decreasing the human negative intervention that affects it. Therefore, architects started to seek for minimizing the negative environmental impacts of buildings by searching for energy-efficient and environmental-friendly buildings.

The environmental, socio-cultural, and socio-economic problems of the built-up environment were successfully solved in the Past within the traditional and vernacular architecture, through employing integrative solutions on both urban and building levels to maintain the occupants' thermal comfort, visual comfort, social integration, in addition to maintaining the architectural identity.

The integrative role of the traditionally used architectural elements (i.e. the 'Mashrabiya' as a perforated architectural model, besides other traditional perforated models) has contributed to the production of sustainable built-up environment, which in turns, encouraged some contemporary architects to imitate them, to borrow and transfer them, or to interpret and develop them in a different way, which led, since the beginnings of the 21^{st} century, to the emergence of a global contemporary trend of using the perforation within the buildings envelopes, due to its great potentials in different dimensions. This trend is still globally rising, especially in Europe, with a variety of designers' intentions, the use of materials, and construction techniques, etc.

The research significance

The different architectural trends include different considerations in solving the environmental problems on both the urban and the building levels, while the greatest challenge of any trend is always linked and subjected to the achievement of sustainable designs, which can be achieved -on the architectural level- starting by the building's envelope design, as the envelope is the most important component to be considered when evaluating or analyzing the building's sustainability or the building's efficiency. The building's envelope is one of the tools of maintaining the architectural quality, occupants' comfort levels (visually, thermally, acoustically, etc.), and the energy-efficiency. Dependently, this envelope can be considered as the barrier or the shield which should be effectively designed to maintain the occupants' needs beside saving the environment, by using integrative holistic designs and sustainable solutions.

When it comes to the new trend of envelope's perforation technique, the same considerations should take their role in the design process to meet the technological, environmental, socio-cultural, and economic needs. In other words, whatever was the system of the building's envelope, it should meet the man's living needs and save the environment. Some questions take a place here: Is there any design reference which concerns with the perforated envelopes in a holistic manner taking into account the technological, environmental, socio-cultural, and economic dimensions altogether? Is there any available holistic design guide for architects or for students of architecture to guide them in designing perforated envelopes?

To answer these questions, a holistic review of related literature has been conducted. The literature's revision showed that very few researchers have published related scientific works, while there is no specific guide to be followed in designing the perforated envelopes. Dependently, most architects are following their independent intentions to design perforated envelopes, which resulted in many differences between the envelopes' design solutions, even within the similar climatic region, or even in the same country.

The literature showed that some researches such as Mainini *et. al.* (2015); Blanco *et. al.* (2014); Blanco *et. al.* (2016); and Cruse (2012) have considered only the environmental issues of the perforated sheets (i.e. thermal behaviour, thermal response, pattern performance, etc.) in some certain contexts such as Spain, Italy, and USA. Other researches such as Sherif *et. al.* (2012); Sherif *et. al.* (2012b); and Sherif *et. al.* (2012c) have the same approach as they discuss the linking of perforation ratios and the rotational angles of the perforated screen with the amount of daylight transmission and the energy use. Similarly, further research such as Appelfeld et. al. (2012) deals with the perforated screens only as standard shading systems, while few types of research such as Abdelsalam & Rihan (2013) have a more related holistic vision when discussing the impact of the different contemporary architectural trends on culture and architectural identity in specific regions.

Accordingly, the review of similar literature showed that the related researches are still very few and very recent, while there is no specific research or organizational and institutional works those include integrated design considerations of the perforated envelope. In other words, there is no evidence for an integrated approach for guiding the design process of a perforated envelope to meet the different dimensions of sustainability.

The critical questions here are: can the design of perforated envelopes remain subjected to the designer's intentions? What ensures the success of this trend in achieving the building user's needs and the environmental requirements? What is the significant contribution of this trend to the achievement of sustainable buildings' envelopes? Following this point of view, the research significance and scope take their places here in exploring the preliminary bases in which the contemporary perforated envelopes maintain a holistic design approach.

Hypothesis and questions

Some of contemporary perforated buildings are designed by globally-known architects or architectural firms, where some of these buildings hold significant certificates or awards such as LEED certification and Agha Khan award. Dependently, the study assumes that the contemporary perforated envelopes have some design considerations and potentials those can be explored and gathered to conduct a holistic design guide for the future. This assumption remains correct unless the opposite has been proven by the research results.

In this regard, a critical question can be raised here: what are the basic holistic guidelines those can be followed by architects and by students of architecture in the early design phases of a perforated envelope, and how they can be extracted? This question leads to the following sub-questions:

- What are the basic technological and environmental aspects those can be considered in guiding the early design phases of a perforated envelope?

- What are the basic socio-cultural and socio-economic aspects those can be considered in guiding the early design phase of a perforated envelope?

These questions represent the research knot which can turn the future design approaches of architects, where this knot is also the starting point for framing an actual research objective.

The research objectives

The envelopes' perforation is not a new concept, it has a significant presence in the sustainable traditional architecture. Therefore, the philosophical and functional concepts of perforation have been revived significantly in the recent years in many different intentions and techniques, which led to a significant change or a leap in the design and performance of contemporary perforated envelopes. Accordingly, and following the global efforts to achieve sustainability in the contemporary and future buildings, this research aims at extracting a set of guidelines to be followed in the early design phases of a perforated envelope taking the technological, environmental, socio-cultural, and economic aspects into consideration, which successively contributes -to some extents- in the achievement of future sustainable buildings.

The extraction of these guidelines comes after making a holistic analysis, an analytical model were structured to be adopted and applied to multi-cases of the contemporary trend in a sustainability point of view, to come up with a deep understanding of the characteristics and the basic rules those have been considered by different architects to produce different perforated envelopes.

The guidelines extraction is an important contribution which aims at outlining a clear starting point for designing the future perforated envelopes, taking into consideration the intersections and interrelations between the different aspects and indicators in the future design approaches.

The research type

The research is exploratory in its type, which adopts the investigatory mode in dealing with the different aspects of envelope's perforation that may connect, strengthen, or disconnect the relationships between man and environment. The exploration process includes both of the qualitative and quantitative methods in the sampling phase, in the results discussion phase, and even in the other phases of the research. The quantified data represents the different numerical outputs, calculations, grouping and ranging, charts, codes, etc., where the numerical inputs are used. The qualified data was used where the comparisons or discussions and evaluations take their place, and when the analyzed components are intangible, descriptive, or unquantifiable.

The research hypothesis is testable since the envelopes' design has some technological, environmental, socio-cultural, and economic indicators those can be certainly analyzed. In addition to this, the intended objectives can be obtained within the time limit by following the adopted methodology, since the needed data are directly and indirectly reachable. Furthermore, the study variables (i.e. perforated envelopes, technology, environmental indicators, socio-cultural considerations, and economic issues, etc.) are basically measurable and manageable, then there is an ability to extract the intended results.

Generally, the research process depends on analyzing a specific representative sample which includes a number of cases of contemporary perforated buildings, to come up with a set of guidelines those can be extracted after a deep understanding of the philosophy and interrelations between the study variables. These guidelines are developed by contacting different related experts and researchers to evaluate them depending on their impact on the early design process.

Research limitations

The research approach has no regional limitations as the trend is global, while the sample selection has climatic limitations since the selected sample includes only cases from the climatic zones where the trend is largely existent, such as: temperate, dry, and tropical climatic zones. Furthermore, the research analytical domain includes contemporary cases only, following its specific objective.

In order to confine efforts and abilities to achieve the desired objectives within the time limits, the guidelines are extracted as general guidelines, while there is a need for greater efforts in the future contextualization and regional appropriateness works. In addition to this, the guidelines development process which relies on evaluating them as a sort of questionnaire has some limitations related to the very few responses of experts and researchers. For this reason, a future extended contextual development process of the proposed guidelines is still needed.

The research has some external limitations governed by the economic and periodic constraints, such as the inability to directly make interviews with architects and experts those designed the selected cases to get clearer feedbacks about their deep intentions for designing such perforated envelopes, And also the inability to visit and observe the selected cases to get a physical inclusion with different implemented works and also with the occupants themselves to discuss their feedbacks.

Despite all, the research results have the potentials to be generalized among different contexts for guiding the future design or for evaluating the already implemented works as a pre-occupancy phase evaluation, while a future extended research can be conducted to outline some experimental developments.

The research structure

The research scope has three main approaches: the theoretical approach, the methodological approach, and the developmental approach. These approaches constitute the main parts of the research structure, which can be briefly clarified as the following:

- Theoretical approach: theoretical here indicates the relevance to the general fundamentals of the perforation trend, as a background. Therefore, this part deals with the theoretical aspects related to the chronological evolution of perforation, in addition to a focus on the conceptual chronological comparison of perforation between the past and the present, to identify changes and possibilities for the re-employment of the trend's potentials in the future. Accordingly, this part has been divided into two chapters: Ch.1) Philosophy and chronological evolution of buildings' perforation, and Ch.2) Conceptual comparison of perforations: Past and Present.

- Methodological approach: this part clarifies the research methods and criteria those were followed in the different research phases, starting with the case selection (study samples) and the collection of the needed data to describe and analyze the selected cases, the methodology also includes the structure of the analytical model and the way of extracting and developing the needed design guidelines. This part has one chapter: Ch.3) Research methods and analytical model

- Developmental approach: this part deals with the intended developments for the future of the trend by extracting a group of guidelines, in addition to outlining the future extended works and visions. Dependently, this part has two chapters: Ch.4) Results of analysis and discussion, Ch.5) Guidelines for designing perforated envelopes.

PART 1

THEORETICAL APPROACH

CHAPTER 1

CHRONOLOGICAL EVOLUTION OF PERFORATION

1.1. Definition

In this research, Envelope's Perforation indicates the substitution of large-sized or normal-sized windows into the building's envelope and replacing them with small-sized holes in order to reduce thermal transfer, to maintain a higher level of privacy, or to achieve other environmental, aesthetic, and functional purposes. The definition includes the perforation that accompanies the presence of windows into the building's envelope as complementary functional components. Furthermore, the definition includes the perforation of both single-skin envelopes and the double skin-envelopes (where it could be placed in front of windows or behind them into a separated perforated layer where the perforated units could be static or dynamic).

Perforation of building's envelope is known among the history of its use as tiny openings into the buildings' facades or roof, to enhance environmental, economic, and socio-cultural needs in the building design (i.e. Mashrabiya in the Arab-Islamic architecture).

1.2. Perforations in the traditional architecture

Among different traditional buildings in several regions of the world, there were many examples of perforated architectural elements or architectural models, especially in the temperate and tropical climatic regions (i.e. Africa, Andalusia, India and some East Asian countries, and the Arab region). This is quite rational due to the appropriate motivations of responding to the local climatic conditions in each region. Furthermore, the socio-cultural considerations have stimulated the use of perforation in certain regions of the world, especially in the conservative communities (i.e. Arab-Islamic communities). Several forms of perforation have emerged in the past and epitomized in models such as “Mashrabiya”, “Takhtabush”, ‘Taqa’, ‘Qamariya’, and the perforated roofs or domes, etc. (Germanà *et. al.*, 2015). These models are briefly explained in the following sections.

1.2.1. The ‘Mashrabiya’ model

The Mashrabiya has different names: ‘Moshabak’ which is common in Iran (Babaei *et. al.*, 2012); and ‘Rawshan’ or ‘Shanasheel’ those are common in the Arab region. Its appearance began in the 13th century during the Abbasid era, but the greatest use of Mashrabiya was during the Ottoman period and continued until the early twentieth century (Kenzari and Elsheshtawy, 2013). Mashrabiya is frequently used in traditional palaces and houses (residential buildings), but it is also used in some public buildings such as Khans, hospitals, etc. (Abdel-Gawad, 2012).

Mashrabiya is one of the leading attributes of the Arab-Islamic architecture, which can be observed in the old cities of Baghdad, Damascus, Cairo, Jeddah, Tunisia, etc. (Fig.1.1). The ‘Mashrabiya’ has many functions such as controlling the passage of daylight; controlling the natural air flow; cooling the air flow and enhancing the natural ventilation; and assuring a considerable level of privacy that is essential for the conservative Islamic communities (Germanà *et. al.*, 2015). According to Hassan Fathy (1986), the south sunlight entering a room has two components: the direct high-intensity sunlight and the lower intensity reflected glare, where the perforations of ‘Mashrabiya intercept the direct solar radiation and soften the uncomfortable glare. Due to this, the Mashrabiya screens have sometimes dynamic openable parts to be flexibly used, and sometimes they are totally static.

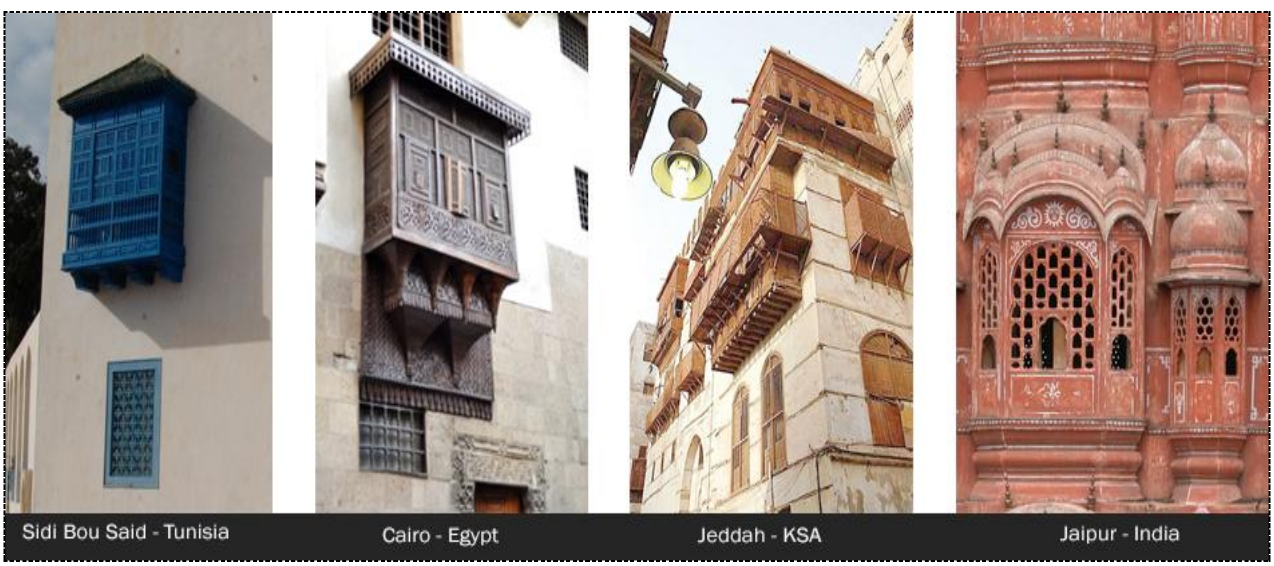

Figure 1.1: Examples of the Mashrabiya in different countries (Germanà et. al., 2015).

The Mashrabiya provides security for occupants, and also its form and its material are considered to have an aesthetic and symbolic values. Sometimes it was made of a wooden lattice (a structure consisting of strips of wood crossed and fastened together with certainly shaped space left between them). As observed and documented in the Louvre Museum, the exhibited archaeological models of Mashrabiya show that the terracotta material was also used historically for the fixed latticed screens in some regions of the world, such as Iran and India (Germanà *et. al.*, 2015). Where these forms are used as archetypical elements to provide the desired levels of privacy (visually, acoustically, and olfactory) in the different regions (Zukelpee *et. al.*, 2014).

1.2.2. The traditional perforated roofs

The traditional perforations of roofs or domes (Fig. 1.2) are a sort of simple patterns into a roof or a dome, those can be observed as small holes of a certain shape which is made by using pottery cylinders or other techniques (Saremi and Gorji, 2015; Germanà *et. al.*, 2015). These perforations help to enhance the passage of daylight to the internal spaces those require extra lighting, without any prejudice to the concept of privacy (i.e. Ayoubi Castle in Aleppo-Syria; Turkish bath in Hebron-Palestine; Zumurrud Khatun Tomb in Baghdad-Iraq). Sometimes, some glass bottles or some transparent materials used to close the perforations to prevent the penetration of rainwater (i.e. Sultan Amir Ahmad Bathhouse in Kashan-Iran) (Germanà *et. al.*, 2015).

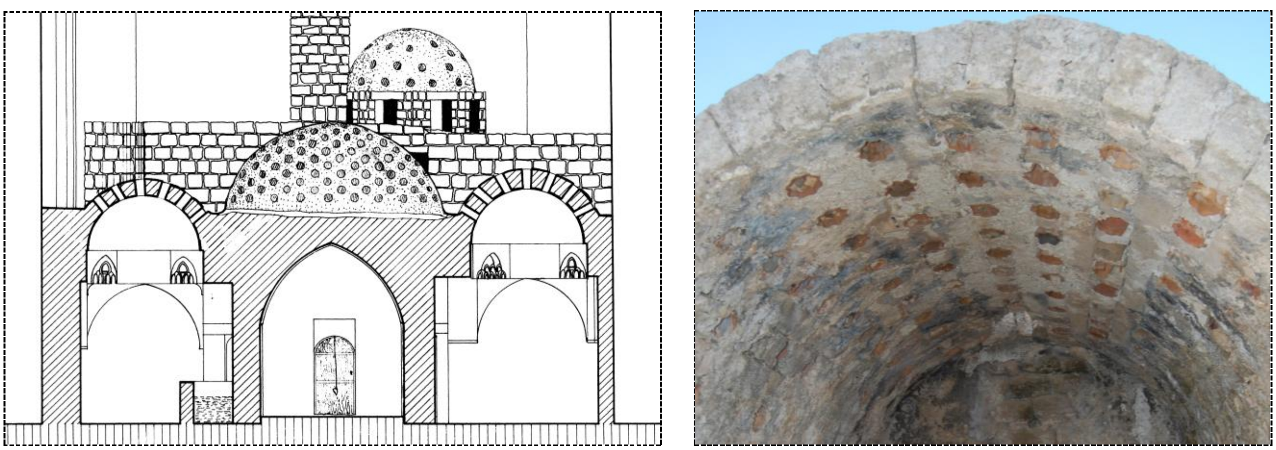

Figure 1.2: Perforated domes and roofs in traditional buildings, (Left: in Hebron-Palestine, Right: in Kelibia -Tunisia). Reference from left to right: Hebron Rehabilitation Committee, Palestine; photo by M.L.G. 2013.

1.2.3. The 'Takhtabush' model

The 'Takhtabush' is a setting area between the house courtyard and the backyard (a type of loggia), with perforated panels that provide shade and increase privacy in the semi-outdoor setting area (Germanà *et. al.*, 2015).

Since the Takhtabush is located between two open spaces (courtyards or yards), a stream of natural air permeates the place of setting by convection property (Waziri, 2004; El-Shorbagy, 2010), which offers a comfortable setting area for occupants. The Takhtabush can be found mostly in the medieval Cairo houses, such as Al-Suhaymi house (El-Shorbagy, 2010).

Figure 1.3: An example of the Takhtabush in Suhaymi house – Egypt (Germana' et. al., 2015).

1.2.4. The 'Taqa' and 'Qamariya' models

'Taqa' is mostly a small simply-shaped opening (rectangular, square, etc.). It was used in a linear array, in a pyramidal array, or some other arrays. Where theses arrays are often placed at the end of the building's facades (some documented images and drawings are clarified by Awad, 2012), or they can be placed above windows and doors of the facades (Fig. 1.4). These elements played a significant role in enhancing the natural ventilation (cross ventilation), and in increasing the passage of natural light into the building (Germanà *et. al.*, 2015).

'Qamariya' is somehow semi-circular openings. The first use of Qamariya was before 4000 years ago in the era of the state of Sheba in Yemen (Smith, 1997). It was often covered by a colored glass and was placed above an external window or the main door to produce a colorful daylight inside the internal spaces of the building, to add an aesthetic or symbolic value (Germanà *et. al.*, 2015). The perforation of 'Qamariya' has several shapes (Fig. 1.4); several decorations (foils or leaves patterns); many colors; and different building techniques. Similar elements were used in the Gothic architecture, in another shape and with different conceptual meanings, such as using the symbolism of light (Fletcher, 1996).

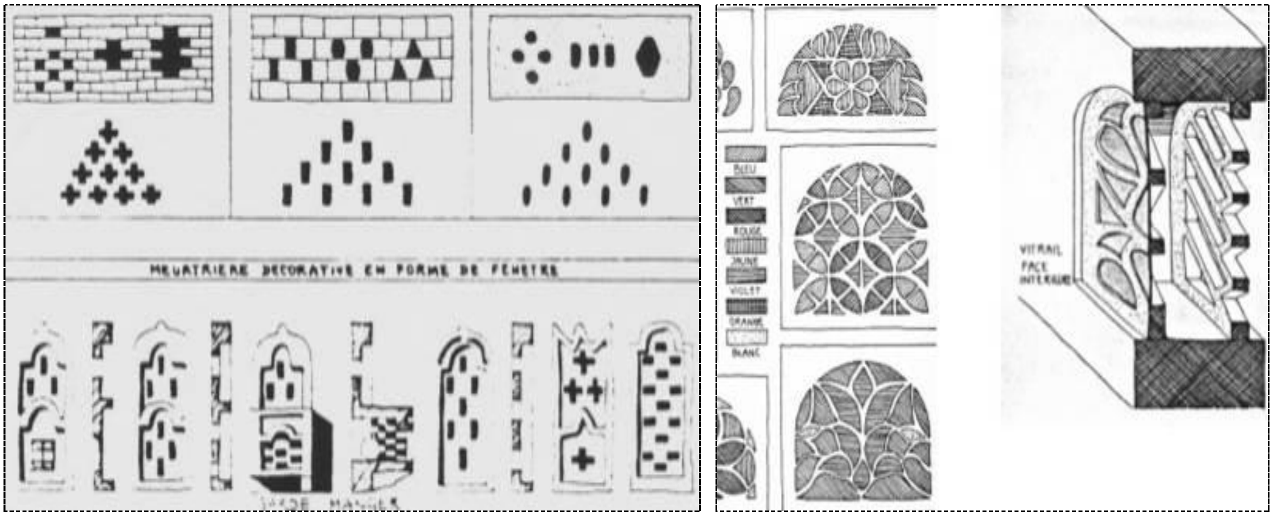

Figure 1.4: Taqa (left), & Qamariya (right), in Yemen (Germana' et. al., 2015).

1.2.5. The pigeon's tower

Perforations of the pigeon's tower play only a functional value, as its role is separated from the role of the building's perforated envelope at the time. But it is still considered as a perforated architectural model. Pigeon towers were mostly found in the social settlements in Egypt and the Middle East since the dawn of agriculture, probably attracted to seeds people planted for their crops. Hence, special pigeon towers were built so that thousands of pigeons could breed in them, their droppings accumulating at their base (Amirkhani, et. al., 2010). These perforated towers had different shapes and different heights.

Figure 1.5: Pigeons towers in Karata Village-Qatar (left: <https://ecubetravelblog.wordpress.com/tag/katara-masjid/>, 05/2016) and in Egypt (right: <https://it.pinterest.com/pin/134474738851016384/>, 05/2016).

1.3. Perforation continuity until the late 20th century

A historical reading of architecture is not the main focus of this study, but an important highlighting for the transformation of perforation ideas can be clarified briefly. The architectural and urban production of the old cities or villages stemmed from the nature of each society, and reflected the realistic image of the life of each community (Waziri, 2004). The relationships between the traditional cities and the socio-economic and socio-cultural contexts are also connected to the climate and to the environmental context (Olgyay, 1981). Many examples showed that the urban fabric of the old cities was derived from the dynamic synthesis of environmental, social and cultural factors. Streets, alleys, and squares played an integrative role on the environmental and socio-cultural levels. Furthermore, buildings were interlocked to each other (back to back buildings), as one system considering the environmental role and socio-cultural connections. This was common in the tropical and in the temperate climatic regions (i.e. the Arab world and the Mediterranean region), a thermal balance was obtained in the traditional buildings to provide a thermal comfort for occupants in hot summer and cold winter, during the day and at night. The balance was evidential in the flooring system, in the underground floor, and in the setbacks of upper floors (Salqini, 2004). It is worth mentioning that the emergence of traditional perforated elements in the architecture of these contexts helped to: (a) enhance the integrative system, (b) allow the passage of natural air, (c) provide an indirect natural lighting, and (d) produce shade and shadows, in addition to its important role in achieving the privacy for occupants.

Since the seventeenth century and across the subsequent centuries, the term of Mashrabiya has been extended for the large wooden panels made with this technique: The Mashrabiya (Ficarelli, 2009). The use of perforation has endured later (in modern cities, in urban expansion zones, in urban fringes, or in rural contexts) as a functional response to the climatic conditions to some extent. Three different approaches synthesize the wide range of the accumulated experiences: an approach during the 20th century, which was disconnected from the past, by using the perforation slightly in a functional way (i.e. Notre dame du haut; Unité d’habitation de Marseille; and Maison de Jeunes by Le Corbusier). The second approach was a disparity of perspectives between imitating, copying, or reshaping of the traditional architectural perforated models in their form (Abdelsalam and Rihan, 2013), accompanying with other individual innovations that took both function and identity into consideration (i.e. Dar Assalam by Hassan Fathy; and Institute of the Arab World by Jean Nouvel).

1.4. Perforation in the 21st century

By the beginnings of the 21st century, a new rising trend of perforation has emerged in the world, by a significant change of techniques, technologies, functions, materials, and other related aspects (i.e. Abbink X de Haas House; Seville Ceramics Museum; San Telmo Museum Extension). The new trend can be perceived to some extent as an architectural leap of perforation as it has emerged in conjunction with the emergence of the digital technology (Germanà *et. al.*, 2015). The main reason is attained by utilizing technological means in the contemporary interpretation of the traditional models, by a reliance on new materials, form, and features (i.e. Masdar City residence in the UAE; Mashrabiya House in Jerusalem; Sea Towers in Abu Dhabi; etc.), while keeping the main concepts (Abdelsalam and Rihan, 2013). The contemporary concepts of buildings' envelopes reflect the complexity of themes focused not only on environmental design, where the external appearance of a building was recognized but also on the relationships between indoor and outdoor environments. Accordingly, the connection between the contemporary trend and the traditional solutions has the potential to rethink of the future advancements in the perforated building's envelope design, in terms of appearance, performance, and its relation to the local context (Germanà *et. al.*, 2015).

CHAPTER 2

CONCEPTUAL COMPARISON OF PERFORATION: PAST AND PRESENT

2.1. Architectural challenges

Architecture is a complex practice that makes use of different traditions, such as styles, crafts, and construction techniques, so it is important not to mix them as one, to be accomplished in different contexts (Savio, 2006). The very distinguished traditions in every urban environment or society are associated with the social and cultural factors prevailing in that society, as the tradition is a product of the interactive relationships between the natural form and socio-cultural structure. While in the recent years, new construction technologies and trends have emerged to show new challenges (Hathlool, 1986). These technologies make the world undergoing the most significant period of technological innovation and global restructuring (Eldemery, 2009). In the technological development process in architecture, the function takes a predominant role beside the evaluation of the surrounding cultural and social conditions (Savio, 2006). Where modernizing the traditions through by rationalization, abstraction or justification of its appropriateness with the current trends is a common way to be included in the world (Özaslan, 2011). Where in this sense, to be modern is the best way to be traditional, since to modernize is the best means to preserve the tradition (Savio, 2006). Perhaps the alternative to the tradition that was proposed anciently deserves to be a theoretical standpoint based on the belief that the issues of nowadays cannot be separated from the frame of time or place. As dealing with the issues of today and the future inherently requires a recognition of the originality and the relevance to the present (Hathlool, 1986).

The different contemporary trends in architecture have great challenges to link between the past and the present. One major difference between modern and traditional buildings is the appearance and configuration of windows and openings (Brunzell & Duric, 2012), where this issue brings a number of contemporary architectural trends those focus on changing the appearance and function of the building's envelope. The challenge of periodic linking can be quietly recognized in the contemporary trend of buildings' perforated envelopes as one of the recent architectural trends, while the question is: can the efforts of linking be considered as successful? Or has a specific solution to be locally disseminated?

Some architects are trying to figure the traditional perforated models in the contemporary trend, such as the interpretation of the Mashrabiya. Dependently, a holistic conceptual comparison between the contemporary trend of perforation and the traditional perforations is highlighted to outline the major changes in the perforation's philosophy. The positive progressive changes can be strengthened in the future, and the negative ones can be avoided in order to maintain a sustainable trend by maintaining the building's harmony with its local context, considering the people's environmental, socio-economic, and socio-cultural needs.

The comparison is firstly based on what has been personally observed, surveyed, and analyzed of several cases of contemporary perforations, as the related scientific writings are still very few. Secondly, the documented information related to the traditional perforated models such as Mashrabiya, Takhtabush, roof's perforated parapets, perforated domes or perforated roofs and other perforations, are considered for making the comparison.

2.2. Technological issues

The unstoppable globalization process led to a technological change and the dissemination of science and new technologies (Eldemery, 2009). While the contemporary architecture resulted in the replacement of new equipment which couldn't always fulfill the social and spiritual roles as did the traditional architecture. Where the application of modern technologies has created independent and discrete spatial elements and has led to the mechanization and industrialization of architecture; under these circumstances, the architecture may fail to play a role in transforming the concept of technology towards rich humanistic concepts in spatial values (Dehkhoda, 1997). Traditional technology is only defined by the needs, as the expert knowledge and skill were at the service of the industrial experts; however, in modern technology, new knowledge and expertise are at the service of the theoreticians (Azarshahr *et. al.*, 2013). However, in addition to these contrasts, the two types of technology also differ from each other in their manner of application and implementation in architecture (Dehkhoda, 1997).

These technological contrasts are still generic which includes many of the architectural trends, even the trend of perforation which has several technological changes those can be recognized in the perforation appearance and performance; orientation or inclination of perforated faces or the perforations themselves; the perforated layer contents; perforation patterns; perforation ratios; perforated materials; insulations; and other technical issues. Where these changes can be mentioned as follows:

1. *Prototypes*

The contemporary perforated envelopes can be partially or fully perforated, while the traditional models were often a sort of partial perforations with a common regional or local appearance and symbolism. For instance, the Mashrabiya was placed on the buildings' facades in a certain repetition either vertically or horizontally as a first prototype, or it was combined with several floors vertically forming another prototype (Abdel-Gawad, 2012, p.3). And the Takhtabush prototype is nearly fixed in its location between the building's internal courtyard and the backyard (Steele, 1988), where it constitutes a partition between the two yards). The traditional models of Qamariya and Taqa constitute also a set of partial perforation in the top of the building's facades, and they were repeated in a certain array (Awad, 2012, p.62).

2. *Roof perforation*

Traditionally, the roof perforation was a sort of perforated domes or vaults, as the flat roofs were rarely perforated, maybe due to structural reasons. Domes or vaults' perforation was formed by creating several holes with regular or irregular arrays to shape the perforation pattern, and sometimes, the holes were filled by empty corked glazed flasks to enlighten the internal deep spaces, which was mostly used in the traditional bathhouses or castles where the building's plan is wide and can't be lit by the façade openings (i.e. Ayoubi Castle in Aleppo-Syria, Turkish Bathhouse in Hebron-Palestine, Sultan Amir Ahmad Bathhouse in Kashan-Iran). This technical solution (roof perforation) was also used to maintain privacy. Contemporarily, it is different, where the roof perforations are very few or limited, due to the need for a vertical extension in buildings, or due to some other reasons such as the use of artificial lighting or the higher glazing areas within facades.

3. *Perforated faces and perforated layers*

In the contemporary perforations, four or more perforated facades can be observed in the same building, which means that the orientation of perforated facades has sometimes no significance. While traditionally, the most influential factor for orientating the perforated models is the socio-cultural purposes, in addition to the environmental ones, to keep the social interaction with outside while maintaining the privacy, natural ventilation, daylight, shading, etc. at the same time. While despite the increasing number of perforated facades in the contemporary trend, the number of perforated layers has no difference between the past and the present, as the number of layers is often about 1-2 layers.

4. *Technical issues*

Despite the presence of pigeons towers in the rural traditional architecture (dramatically in the Arab region), the perforation ratio and thickness of the perforated layer in the cases of Mashrabiya and Takhtabush were turning without the bird's ability to nest inside them. Furthermore, the occupant's daily contact with them also helps in preventing the bird's permanence inside them for a long time. Nests lead to the dirtiness of the place and increase the chance for bacteria and mildew growth. The situation was not the same in the traditional Taqa or Qamariya, they allow the birds nesting, as well as in the traditional perforated parapets those have the suitable size of perforation for birds. Despite all, pigeons breeding was one of the means of livelihood to the rural man, since this issue was not worrying about him.

In some contemporary cases, the use of thin perforated layers, especially when using metals, prevents the birds to nest. While in some other cases of thick perforated layers with suitable perforation’s size, it is possible for a bird to nest.

5. *Perforated surface*

Generally, the traditional perforated models have mostly flat, curved or organic surfaces, perhaps, due to construction purposes and the use of conventional materials. For instance, the rural mansions or the pigeons’ towers were cylindrical, conical, organic, or irregular (Amirkhani *et. al.*, 2010). Meanwhile, similar geometrical surfaces shapes can be observed contemporarily in addition to other several complex forms, while the use of flat perforated surfaces is still dominant.

6. *Perforated material*

Traditionally, in Asian tropical climatic zones such as India, windows often include screening elements, such as in wood or stone latticework, to block the direct sun while bringing in light and air. They were also used in tropical and non-tropical climates (Hildebrand, 2011). Wood, bricks, earth, stone, pottery, and terracotta were mainly used for Mashrabiya, Takhtabush, and other perforated models. In the case of Mashrabiya, the wooden lattice was dominant in the Arabic region, while in India, Pakistan, and Iran, the stone Mashrabiya was the dominant (Germanà *et. al.*, 2015).

Recently, a noticeable change to the types of perforated materials happened. Some innovative perforated materials have emerged, which may help in improving technically treatments of perforated materials. While the use of perforated metals takes the primacy despite the climatic differences. The brick is still used in some eastern world countries (i.e. Cambodia, Vietnam, Thailand, Australia), with a decline in using wood, stone, terracotta, and ceramic, since the perforation has become almost an external layer in the case of double-skin envelopes. This seems technically as a rational change, due to the easiness of implementing the lightweight perforated panels (Germanà *et. al.*, 2015), and to facilitate the opening/closing operations by folding or by sliding them, etc.

7. *Double-skin envelopes*

Apart from the number the perforated layers, the envelope's air cavity in the traditional perforated models was almost inexistent, as they were parts of the main building skin. In other words, the double-skin perforated envelopes can't be commonly found in the traditional architecture. However, the double-skin perforated sheet facades are showing an increasing tendency in the contemporary buildings' design (Blanco *et. al.*, 2016), considering the external perforated layer as a second environmental protective skin for the building.

As a transitional space, the air cavity was inexistent in the traditional architecture of the same form. Traditionally, there was no physical separation between the building occupants and the external envelope's layer, so as not to prevent occupants from interacting the outdoor environment. For instance, in the case of Mashrabiya, this transitional space was created by just raising the Mashrabiya level above the main floor level, then it becomes a setting place to keep viewing outside (Fig. 2.1). The air cavity can be seen contemporarily in three different types: a) narrow and inaccessible air cavity, b) wide, but inaccessible air cavity, c) wide, but accessible air cavity.

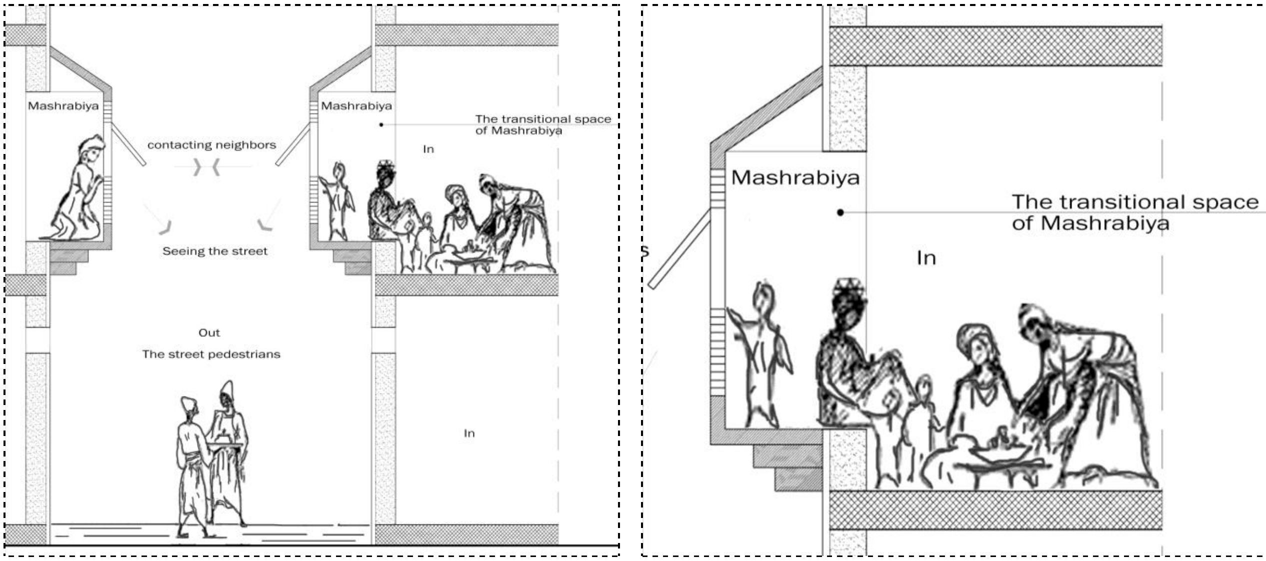

Figure 2.1: The Mashrabiya as a transitional space (Germanà et. al., 2015).

***8.** Thickness of perforated material*

In some traditional perforated models, such as ‘Taqa’, the perforated layer thickness follows the main envelope thickness, as they are a monolayer. The perforated layer thickness in other perforated models depends on the used construction material in that time or that location. Where in the case of wooden Mashrabiya, the perforated layer was thin, within few centimeters, to commensurate with the capacity to carry the Mashrabiya weight, which was often prominent outside (Abdel-Gawad, 2012, pp.40-113). Contemporarily, the layer’s thickness was much paradoxically different, as the architects have used very different perforated materials, either in the case of single-skins envelopes or the double-skin envelopes.

***9.** Supporting windows*

Windows are the tool which the occupants use to modify their different levels of comfort (visually, thermally, acoustically, olfactory, etc.) by opening/closing them (by folding, sliding, swinging, reversing, axially, etc.) upon their desire. Traditionally, when the perforated model is static (not openable) there will be other open-able windows onto the same facade, or onto other facades but for the same internal space. This remains valid for the contemporary trend, while there are some cases of fully or partially static perforated envelopes without openable units (Fig. 2.2), neither manually nor technically.

Creating static immovable envelopes is critical, it is like putting the building inside a cage. Such situation was almost inexistent in the traditional architecture, there were windows or openable units within the perforated parts or within the nearby parts of the same façade, to stay without affecting the interaction between occupants and the surrounded context.

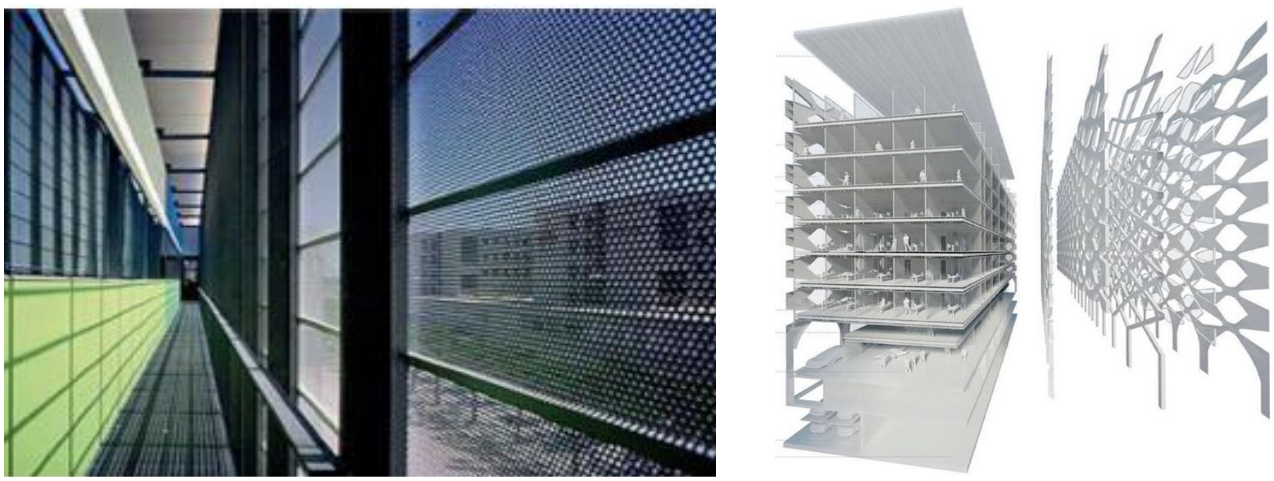

Figure 2.2: Examples of fully perforated envelopes with no openable units. Left photo ref.:(Blanco, et. al., 2014), right photo ref.: <http://www.bianoti.com/exploded-diagram-architecture.html>, (03/2016)).

2.3. Environmental issues

According to Gupta (1987), today, architects identify apertures in the building with glazed windows, and they expect such apertures to serve a number of environmental functions, namely those of providing light, ventilation and view. Having no access to glass as known, the indigenous builders designed apertures to serve one function only, while a number of different apertures combined together to meet the needs of light, ventilation and view. They were not having to worry about the other functions, each of these apertures could be optimized for one purpose, leading to a more satisfactory thermal design (Gupta, 1987). Not only windows but also shutters, screens, and pergolas should allow ventilation, lighting, and view but simultaneously control the penetration of the sun in summer (Serghides, 2010). Each opening in the building's envelope has to take its function, whether it was for view only (Fig. 2.3 left), or it was for getting a view, ventilation, and decreasing heat transfer at the same time (Fig. 2.3 right).

Traditionally, the functions of perforation were about maintaining privacy; simulating the environmental requirements; adding aesthetic values; while achieving an architectural identity. The contemporary perforations are mostly based on Aesthetic aspects, whereas the basic energy saving principles are not taken into consideration, which leads to a general discomfort inside the building (Blanco, 2016). While there are some cases have employed the environmental solutions.

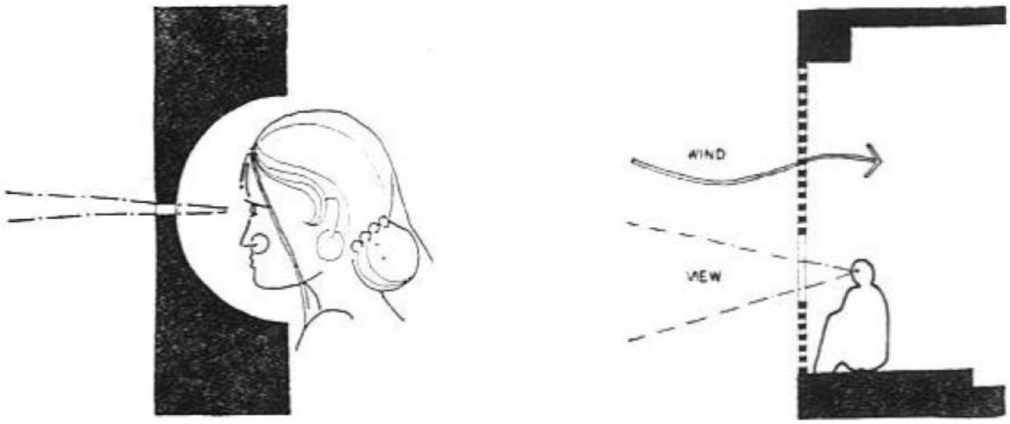

Figure 2.3: Left, a small perforation into the wall of Amber Fort-India to view outside. Right, a large window with a perforated screen into the wall of Amber Fort-India for viewing outside and ventilation (Gupta, 1987).

Dependently, the prospective functions of perforation, all or most of them, were often met traditionally to form integrated functional models. While in the contemporary trend, the integrative role is almost missing, even in the cases of interpretation of Mashrabiya, as they missed the socio-cultural value (Fig. 2.4).

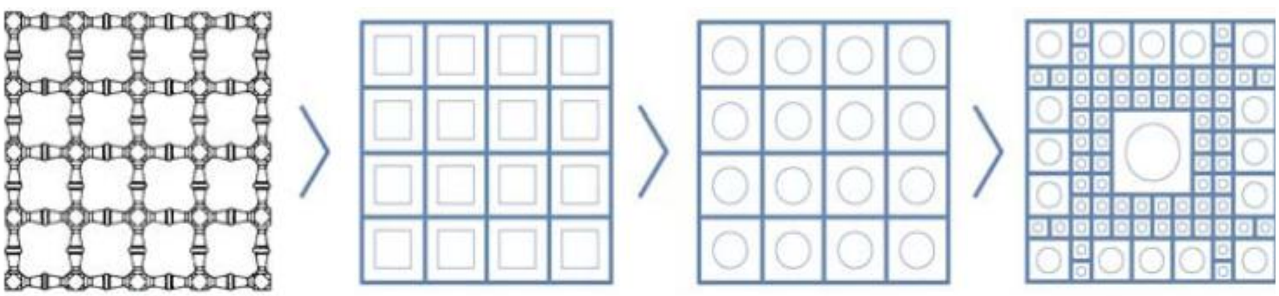

Figure 2.4: A contemporary metaphor of the traditional Mashrabiya, <https://yimingsu.files.wordpress.com/2010/12/arab-institute-jean-nouvel.pdf>, (02/2016)).

Furthermore, it is arguable that the environmental differences between the traditional and contemporary perforated buildings are almost related to the urban level. Where the traditional urban context was harmoniously environmental, it was working as one physical unit to maintain the environmental requirements besides achieving other various societal needs. While contemporarily, the environmental attention is more oriented towards the building level, with little attention towards the integrated physical urban fabric, except in few cases such as newly emerging cities (e.g. Masdar City, UAE).

On the building's level, there are many factors those can be considered in deciding how much the building is environmentally treated, such as: controlling thermal transmittance, getting adequate natural lighting and natural ventilation, providing shades and shadows, using high capacity and well treated construction materials, utilizing renewable energy, designing responsive building envelopes, and respecting the nature and the surrounded context, etc. The changes to these basic environmental functions of perforation can be highlighted as follows:

1. *Thermal performance*

Traditional buildings were mainly designed and integrated together to provide the maximum protection from solar radiation and direct sunlight, on both urban and architectural levels. Unlike the contemporary buildings, where many of them are designed with less consideration to the changing climatic conditions from region to region, and even the social context itself.

In regards to the thermal performance of perforations, the lighter and deeper solar screen configurations were found to be more efficient in energy consumption (Sherif *et. al.*, 2012). Contemporarily, the perforation ratios and even the perforated materials were often determined without any significant environmental reference, they were considered sometimes for technical purposes, or aesthetic purposes (Germanà *et. al.*, 2015), rather than the need for a sunlight control. Sometimes, the perforations were large enough in their size to the extent of a window size, and sometimes they were very tiny, which may impede the visual interaction with the outdoor environment. According to Serghides (2010), small openings in the east and the west can help to avoid the summer sun in the morning and the afternoon (in the Mediterranean climate). Unlike the woven solar screens, wooden solar screens have a thickness that provides selective shading properties. Perforated wooden solar screens were traditionally used for windows shading. Developing modern types of these shading systems can lead to significant energy savings (Sherif *et. al.*, 2012).

However, the perforation ratios in most of the traditional models were decided in regards to the desired level of privacy and environmental needs. For example, perforation ratio of Mashrabiya follows the environmental needs and the conservative community rules, where the revealing and veiling are importantly organized. Dependently, the traditional Mashrabiya has almost a local or regional unity of perforation ratio, with a significant sign of the local identity, which helps the observer to distinguish its geographical location and even the historical period.

2. *Shading*

On an urban level, the traditional buildings were built as one combination in providing shades and preventing the undesirable heat and wind, by using thick and heavy weight envelopes those decrease the heat transfer. Moreover, streets in old cities were almost narrow and shaded, which in turns enhances the cooling of air and increases the air velocity due to the suction process. Where the wide streets usually took a north-south direction at right angles to the path of the sun, to keep them in shaded most of the daytime.

On the building's level, utilizing from the exterior shading with windows significantly reduces the need for cooling by reducing solar gain (Hildebrand, 2011). Where the Mashrabiya as a shading screen has a role of providing shaded zones within streets to protect the passers-by from the direct sunlight, also it provides a partial encasement from rainfall (Fig. 2.5). It has also several functions on the building's level such as: controlling the passage of daylight, controlling the natural air flow, reducing heat temperatures inside by cooling the air and ensuring the privacy. Each design of Mashrabiya was selected to fulfill several or all of these functions (Ajaj and Pugnaloni, 2014).

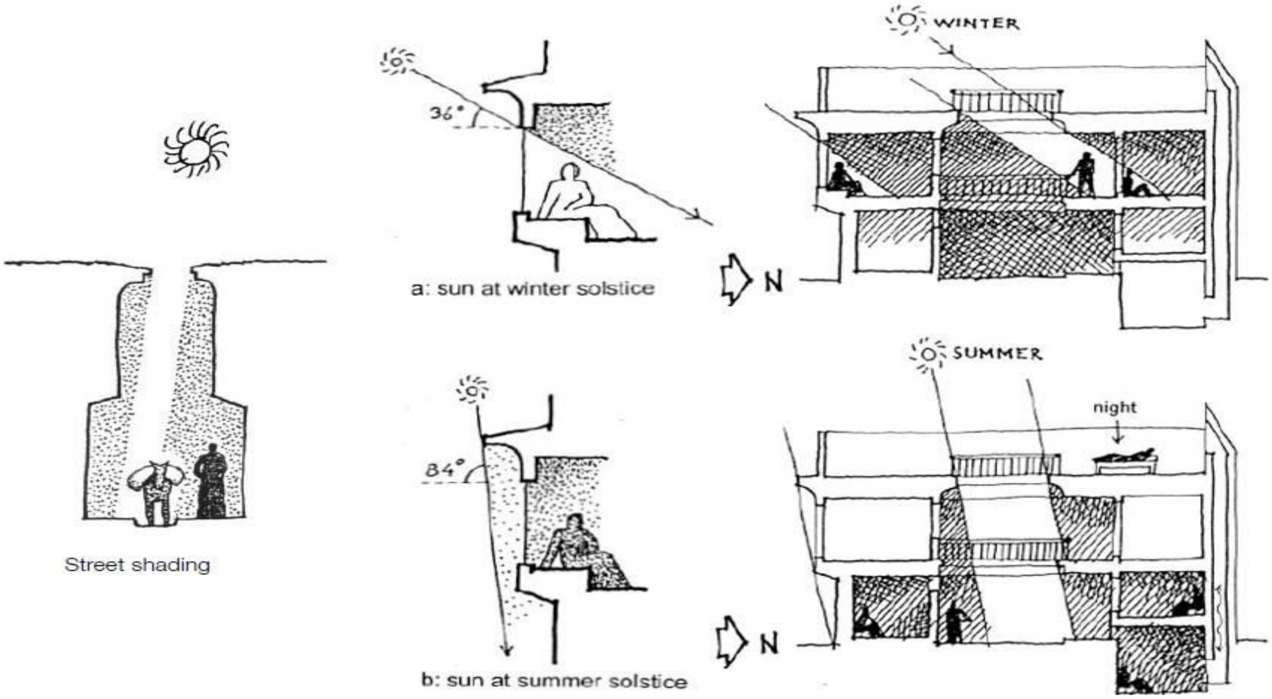

Figure 2.5: Traditional control of the sunlight passage during summer and winter (Ragette, 2003, p.86).

The other traditional models also have contributed to some extents to maintaining the integrative environmental functions on both of the urban and the building levels. The Takhtabush, as an example, was designed to contribute to the passive ventilation system by locating it between two inner courtyards within the house, where it constitutes a connection point between the two courtyards. The northern courtyard was a large open space and was meant to have low surrounding walls in order to keep the space sunny and relatively hot. The passive ventilation design solution is confirmed by comparing the shade in the northern courtyard to the southern courtyard. For example, according to Attia (2006), in Al-Suhaymi house in Egypt, the amount of shade in the northern courtyard during winter (21 December, 2:00 p.m.) is more than 53% compared to 100% in the southern courtyard space, while the amount of shade in the northern courtyard during summer (21 June, 2:00 pm) is more than 12% compared to 40% in the southern courtyard (Fig. 2.6). This confirms that when temperatures rise in the north courtyard, the air flows against the north prevailing wind directions during most the daytime. Meanwhile, the wind flows passing the southern courtyard into the Takhtabush reaching the northern courtyard. On the other hand, the prevailing wind flows from the northern courtyard when the sun drops down afternoon through the Takhtabush to the courtyard, and so on (Attia, 2006).

Figure 2.6: The passive cooling system of The Takhtabush, Al-Suhaymi house, Egypt, where (A) the air movement during noon, and (B) the air movement afternoon, edited from (Attia,2006, p.2,).

Contemporarily, the absence of well-shaded streets within the new urban fabric, increases the exposure of buildings envelopes to the direct sunlight, which leads to an increase in the heat transfer inside the buildings, especially in the case of using thin lightweight perforated materials as shading screens, or the use of materials those have a quicker time-lag for heat transfer (i.e. metals). Here, a thermal insulation is crucial for maintaining a thermal balance in such cases.

Despite all, the contemporary trend of perforation has a certain attention towards the environmental issues including provision of shades, control of light and air passage, etc. (Germanà *et. al.*, 2015), as the shading screens block the solar gain, to some extent, while they obstruct airflow into the building (Hildebrand, 2011). However, the ambiguity is about how much the contemporary solutions are environmentally and economically efficient? how much are they visually comfortable? And how much they contribute to producing an integrated environmental urban fabric?

3. *Daylight and natural ventilation*

Through most of history, ventilation and shading were a commonly used passive cooling strategy in building design. Different traditional architectural elements provided the buildings by the adequate and comfortable levels of direct and indirect daylights and natural ventilation, whether they are perforated or imperforated (i.e. wind catchers, Mashrabiya, Takhtabush, courtyards, etc.) beside their contribution in maintaining thermal balance on urban and building levels. Today, in a large part of the world, natural ventilation is still a main form of cooling, while it is common for many buildings today to heavily rely on air conditioning to achieve thermal acceptability (Hildebrand, 2011). While the design can simply employ the passive cooling solutions (i.e. smaller openings or perforations are needed in the north to avoid cold winter wind, but also for the achievement of cross-ventilation in summer. And some small windows or perforations can be placed mainly above the staircase for ventilation (Serghides, 2010)).

In hot and humid areas, trying to shut out the unpleasant weather does not work well. Electricity for fans or air conditioning is unreliable and condensation from humidity causes more problems than the heat. Opening to the breezes is much more effective. Recently, peoples of hot-humid regions define buildings as roofs with spaces blending from indoors to out through perforated screens instead of walls, allowing breezes in. A sense of security and enclosure may come from people or a compound or a courtyard wall more than the building walls themselves (Stouter, 2008).

Many contemporary interpretations of the Mashrabiya have emerged in order to reduce glare and solar gain (CTBUH, 2012). Where those screens act as a baffle zone between the interior and the exterior, so the glare of sunlight is broken up by the lattice that provides a dark area. In addition, this is found to be relatively effective in reducing the maximum indoor temperature in hot weather (Mousa and Lang, 2014).

2.4. Socio-cultural issues

The architectural expression should respect regionalism in a multi-disciplinary design approach. On the other hand, the global mass knowledge and technology should not be ignored. Where the architecture must be a synthesis of both aspects to create a harmony with the traditional values; suitable for the contemporary societies and their cultural identity and human scale; and based on the appropriate technology (Serghides, 2010).

The traditional architecture was intended to confirm the local cultural and regional identities, and other features such as prospect; spatial organization; reminiscence; interpretation and unity, those are supposed to be distinguished in traditional architecture. Architecture is the product of the interaction between human beings and the environment. Also, it is the interaction of society with history. In other words, architecture is regarded as the incarnation and embodiment of the social spirit to a location. Architecture and urban life have surpassed the limits of physical existence and give an array of understandings and feelings of the location and its components to the attendees (Azarshahr *et. al.*, 2013). Nevertheless, globalization has become a catch phrase in architecture associated with a loss of place identity. There seems to be a general consensus that identity plays a significant role in the continuity of man's culture; otherwise, he will be cut-off from his past. Hence, the place can be described in terms of multidimensional physical and psychological environmental attributes (Eldemery, 2009). The place can be influenced by the meaning that occupants give to it through personal, social, and cultural processes (Altman and Low, 1992; Burd, 2008).

The disappearing architectural identity caused big debates between architects those obtained different approaches in the last few decades. Dependently, the identity and cultural issues of architecture are not subjected only to the perforated architecture, there is a noticeable leap in the contemporary time in terms of the cultural and social relationships between people and their living contexts. This issue has started recently to take a great attention by bringing it to be one of the sustainability dimensions those advocated by all professionals.

Dependently, the chronological comparison of the socio-cultural issues in regards to the theme of perforated architecture between the past and the present, relies on three main aspects: a) the usability of the perforated envelope and the perforated models, b) the adaptability of the building's occupants with the envelope design, c) the connectivity of both the occupants and the envelope's design to the local context.

1. *Usability of the perforated components*

The use of perforated models or envelopes lies on the extent of occupant's ability to physically access and control them for maintaining their visual, thermal, and acoustic comforts, and also to maintain the desired privacy. As a simple illustrative example, occupants can open a window if they feel hot, or to increase the daylight passage to inside, and they can perform to close windows if they feel as they are revealed by the neighbors or the passers-by in order to maintain a higher level of privacy. These are the great reasons lie beyond the emergence of perforation.

Nevertheless, perforation doesn't eliminate the need for windows within the building's envelope and doesn't eliminate the need to control the windows. Since the visual comfort and the connectivity to the place and the local community are also considerable needs. In this regard, Mashrabiyya has two types: the static Mashrabiya which has the role of increasing ventilation and daylight transmission inside while maintaining the privacy, and the openable Mashrabiya, which is easily controlled upon the occupants need. Therefore, the building may have both types at the same time or at least it may have supporting windows, so as not to deprive occupants of their needs to communicate with the outside community and control the envelope's components upon their desires. This matter can be noticed as the opposite in some contemporary cases of perforation, where the windows or the openable parts are almost inexistent within the envelope's perforated layer (static perforated layer). Sometimes, the open-able components are limited to parts of the façade without others.

The second considerable factor that influences the usability of the envelope is the spatial accessibility of occupants to the perforated layer or the external envelope's layer. Where sometimes, the inaccessible air cavity in the double skin perforated envelopes prevents occupants from controlling the external perforated layer, and even decreases their ability to view outside if the perforated layer is static (Fig. 2.7). While, traditionally speaking, the double-skins were almost nonexistent in the perforated models; the Taqa and Qamariya were supporting openings onto the building's facades; the static Takhtabush, static perforated roof parapet, and static perforated roofs were just complementary elements. Accordingly, the occupant's accessibility and controllability of the building's envelope was not affected. And even in the case of Mashrabiya with its all types, it was functionally workable for enhancing occupants' comfort (Fig. 2.7).

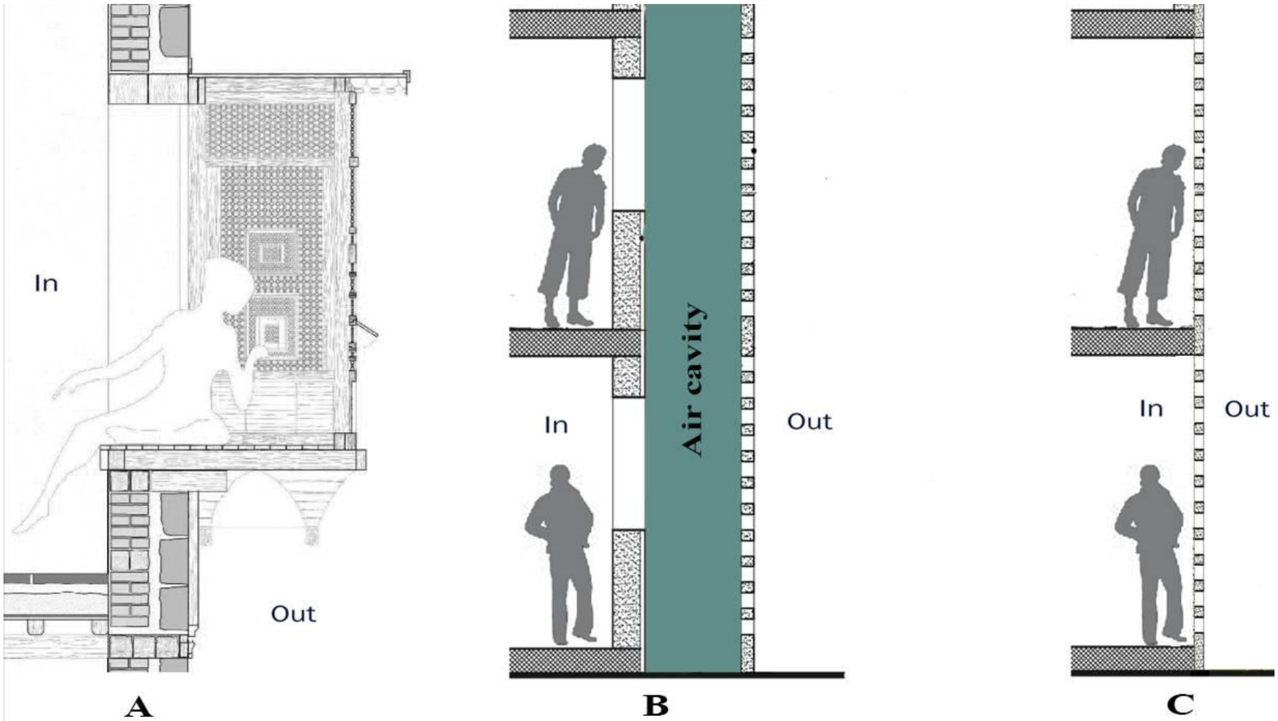

Figure 2.7: (A) The Mashrabiya model (Ficarelli, 2009), (B) Inaccessible contemporary transitional space, (C) contemporary single-skin with inexistence of windows.

In the contemporary trend, the transitional space was noticed, in some cases, as separated from inside by either fully or partially solid wall, or by a glazed curtain wall, and separated from outside by a fully or partially perforated layer. The air cavity has three types: narrow and inaccessible; adequately-wide but inaccessible; and the adequately wide and accessible (i.e. Mashrabiya House, Jerusalem). Where the adequately-wide inaccessible space can be considered as an extreme case for influencing its usability by occupants. Another extreme case is the single skin fully or partially static perforated envelope with the inexistence of open-able components or supporting windows at the same time (Fig. 2.7, C). Those two cases are considered as extreme due to the significant difficulties of occupant's ability to control or to access them, which may negatively affect their comfort. Dependently, a new term can be given to express the extremeness, which is *"The Cage Form"*. Unlike the Mashrabiya which can be considered of its all types as *"The Veil Form"*.

The metaphoric Mashrabiya has been emerged recently as a trend by obtaining different approaches of repetition, imitation, eclecticism, interpretation, or simulation. However, these efforts can't be considered as ideal, as they disconnect it from its socio-cultural contexts and its actual roles (Germanà *et. al.*, 2015). Castells (1996) confirms this as: *"Space, in the social theory,* *cannot be defined without reference to the social practices. It is an expression of society, and is a material product, in relationship to other material products, including people who engage in historically determined social relationships that provide space with a form, a function, and a social meaning"*. Despite all, there is a potential to re-benefit from the advantages of adequately-wide accessible transitional space, to be developed and obtained as social space in more innovative ways in relation to the local social contexts, to be a new "*Noble Mirror*" of the Mashrabiya.

2. *Adaptability*

The envelope is a physical means that defines both inside and outside the building, where occupant's emotions, connections, and perceptions (sensory perception, visual perception, mental perception, etc.) towards the outside environment might be influenced by the way in which the envelope was designed to connect them to the environment. In other words, the type of envelope changes the way of interaction between inside and outside.

An attention should be given to the effectiveness of the manually operated solar screens, especially when the design concern extends beyond the thermal and physical determinations, where the decision to control the solar screens is dominated by considerations other than energy and thermal comfort, it is often circumscribed by environmental as well as, economic and behavioral considerations (Serghides, 2010). Occupants adaptation with a certain envelope's type is governed by their ability extent to interact the surrounded environment and to meet their desired needs. Therefore, the building envelope can't be a barrier between occupants and the outdoor environment, where it should be a means of connection, and a means of maintaining security and privacy at the same time. If so, occupants can easily adapt with the building's envelope. Successively, the acquired quality of occupants needs (connection, security, privacy, etc.) affect the level of adaptation with a building's envelope. For example, a fully solid envelope deprives occupants of maintaining the daylight; natural ventilation; and the visual contact with the outside, etc. While, a fully transparent envelope deprives the conservative occupants of maintaining the desired privacy. Here the perforation has its main role, traditionally and contemporarily, which can provide the occupants by their desirable needs which allow them to easily adapt to the design.

As confirmed by RMIG (2014); and Serghides (2010), that the perforated envelope can provide occupants with adequate levels of security; safety; privacy; thermal comfort; acoustical comfort; and visual comfort; etc., with an attention towards the design flexibility to allow the occupants' changeable behaviour inside the building. Here, the new technology has its actual role in solving the environmental problems, but it shouldn't be the first and the last solution for architects since the architectural solution should be holistic.

Traditionally, the privacy levels were not limited to only the visual privacy, but an attention was given to the acoustical privacy and even the olfactory privacy (i.e. some traditional homes owners in the Middle East commonly used the incense to disinfect the house and to control the olfaction produced from cooking areas (Othman *et. al.*, 2015)).

The very tiny sizes of perforations can provide more privacy and security, but at the same time, occupants may lose their visual comfort, especially when *"The Cage Form"* takes its place in the envelope's design. Thus, the issue of adaptation would be to somehow complicated, unlike it was in the traditional models. In this regard, *"The Cage Form"* should be well modified in the future by benefiting from successful experiences, as well as to be a new innovative development for *"The Veil Form"*.

3. *Connectivity to the local context*

The perforation's pattern contributes to changing the building's appearance, where it can express its architectural identity in different regions; it can also express the building's use. This appearance can be also achieved by using distinguishable building materials; openings; and ornamentations or decorations. Contemporarily, using common global materials; techniques and methods; and using indistinguishable openings or perforations shapes, seems like an adoption of neutrality that led to non-discrimination of a new building's identity or its use. The contemporary perforations often have no significant relationship to the local identity (Germanà *et. al.*, 2015). While, different traditional models added, in several cases, an indication of the building's identity, especially the Mashrabiya and the Takhtabush, their materials also facilitate creating the floral and geometric motifs to express the Arab-Islamic identity (Abdel-Gawad, 2012, p.4). On the other hand, the traditional roof parapets, and Taqa patterns were reflecting the rural architecture in their simplicity in several cases, as clarified by Awad (2012).

The formations of perforation in the past stems from the identity and the conservative society rules, or from the simplicity of the rural architecture. While nowadays, the neutrality is dominant in the formation of perforated patterns, perhaps to evade from the complexity of imparting the identity, or perhaps to comply with the technical requirements of the new constructions. Which in turns alienate the building from its local identity.

The building's connectivity to its local context is associated with two levels: the appearance Level, and the performance level. The traditional architecture was linked on both levels to local environments. It is obvious in an enormous number of traditional cases among the world that connection between man, architecture, and the local context was a complementary and an interactive process, where the built-up environments were organized to maintain the continuity of life and the natural environment in a consistent and sustainable way. Contrary to this, most of the contemporary architectures, and even the architecture of perforation seems as a global exaggerative fashion with different approaches. Since for example, no significant distinguishable appearance between a building in Gulf region and a building in Europe. The reliability in those designs was high in achieving environmental requirements far from considering the socio-cultural and economic issues.

Furthermore, linking occupants with the outside environment is a very significant design issue. Where the role of the building's envelope is not limited to the level of controlling the daylight transmission; heat transfer; ventilation; shading; etc. It extends beyond that role to contribute in facilitating and balancing the visual and physical contacts between man and environment.

The flexibility of perforated envelopes provides better interaction between occupants and envelope, and even between occupants and outside, by enhancing the performance level. The flexibility (dynamism) of a perforated envelope is not the only influential factor of connectivity since the tiny-sized perforations in a fixed perforated layer make the interaction more difficult, or very limited in some cases. It is clear that climate plays a certain role in determining the perforation ratio. However, this shouldn't lead to the production of only environmentally-solved envelopes (Germanà *et. al.*, 2015).

The performance level of connectivity may differ from a building to another (i.e. privacy is desired in lower levels in a public building in comparison to a residential one). Also, the level of desired privacy differs from a community to another, as it is crucial for conservative communities, which dramatically has led to the existence of Mashrabiyya in the Muslim communities (Fig. 2.8). The commitment to the jurisprudential (*Fiqh*) rule in the Islamic culture which aimed to avoid the detriment of the unveiling, had a great influence on the shape and decoration of the façade perforations in the traditional residential buildings. The main impact was twofold: firstly, it led to the screening of building perforations with turned wood works, either in the Mashrabiya or in the windows themselves. Secondly, it led to the emergence of a rule by which prohibited to open one’s perforation just in front of a neighbour’s perforation (Abdel-Gawwad, 2012, p. 6). Where different interactions between people, such as; visibility; vocal interaction; accessibility; proximity; and olfactory interaction, were highly considered in Islamic communities. They were sometimes semi-restricted communications, on the public level, where people can easily communicate each other (visually, vocally, etc.), depending on the relationships between persons (i.e. gender to gender; relative to relative; or neighbour to neighbour), with a respect to the women's spatial privacy (i.e. a man can visually contact a veiled woman once, and he is not allowed to contact here verbally for no crucial reason, in some cases).

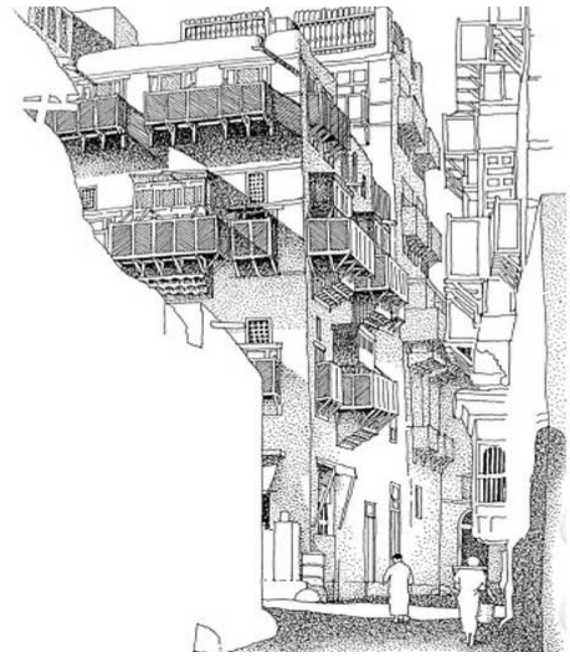

Figure 2.8: Mashrabiya, a model for a conservative connectivity to the local context in the Arab-Islamic communities. Left photo shows the Mashrabiya from inside (Le Bon, 2012), right photo shows the dominance of Mashrabiya in traditional buildings. (Ragette, 2003).

Also, the semi-restricted communications take place in the case of contacts from a private space to a public space (i.e. a woman can observe the street from inside the Mashrabiya without being visually revealed by pedestrians, where the vocal communication is limited to persons those she wants to talk to them (Fig. 2.9)). The semi-restriction also takes a place the case of contacts from a private space to another private space in the adjacent building via a public space (i.e. a woman can talk to a woman in a nearby house on the opposite side of the street from inside the Mashrabiya without being visually revealed by pedestrians (Fig. 2.9)). This is *The Veiling Form* of perforation in the traditional Arab-Islamic architecture, where no full-restricted communications (no disconnection of people from the community), the societal and spatial communications were carefully controlled and managed to integrate people with their communities.

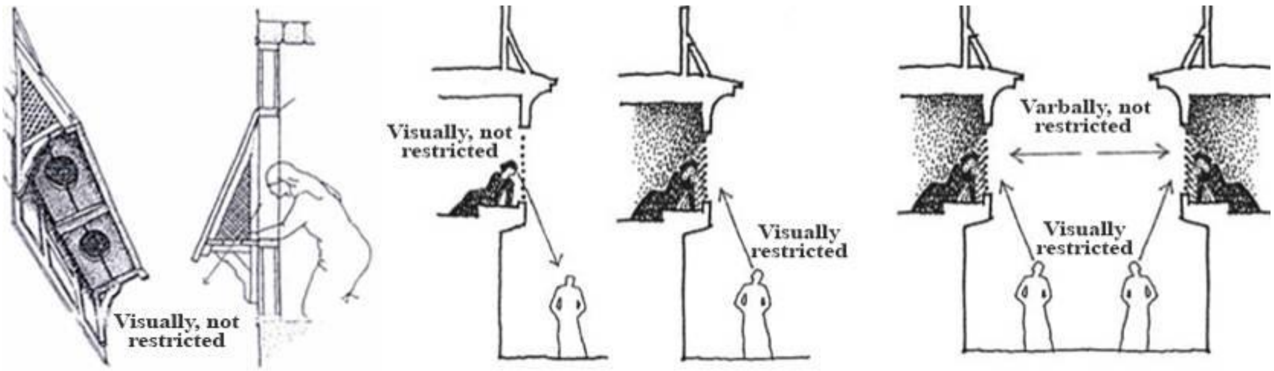

Figure 2.9: Visual and vocal restrictions in the conservative traditional Mashrabiya as a veiling form (Ragette, 2003, edited by the researcher).

Privacy and conservation vary from person to person and from culture to culture, from period to period, as the societies and social ties, are continuously transforming and changing (Georgiou, 2006). Meanwhile, they social connectivity can't be neglected in the spatial settings, as the community should be continuously integrated. Despite all, there are some contemporary cases can be considered as relatively successful in enhancing the building's connectivity with outside to some extent (i.e. Mad Building in Oslo-Norway, 2013). However, a critical consideration must take its place in dealing with the extreme cases of perforation, and a greater attention should be paid toward a holistic sustainable approach in the future of perforation trend.

2.5. Economic issues

The building's envelope acts as a thermal shield reducing the demand on HVAC equipment, improving indoor comfort, and extending the lifespan of building's components (Kadlubowski and Yates, 2009). Accordingly, the energy-efficient building's envelope is becoming a standard practice, where more work is needed to reduce costs and increase performance so that more cost-effective applications are available to builders and designers. Today, most advanced building's envelope alternatives, including the perforated ones, are cost-effective over a long-term investment period, but they require greater initial capital costs. Where reducing initial costs and increasing annual savings result in producing advanced building envelopes. Therefore, establishing specific cost and performance criteria for the entire world is almost impossible because factors such as climate, occupant behavior, construction practice and availability of resources vary widely (IEA, 2013).

The local availability of the envelope's external material is a cost-influential factor, as it can be more economic. Traditionally, the used perforated materials in different parts of the building, including the different perforated models, were conventional and locally available materials, which highly reduces their costs. And even the traditional construction techniques and the implementation process are well known as economic, due to the public participation in the construction process, without the need for advanced technology and manpower. As for the contemporary constructions, they need greater work and more advanced technology that cannot be served by the traditional construction methods. While, the use of perforated metals and other materials those are not confined to the local context, can increase the building's initial costs and even the running costs, in addition to their environmental problems those may appear in case of unsuitable contextualization, besides losing the affiliation to the place and community.

It is not a suitable solution to return to the old techniques and traditional materials by putting away the renewals and innovations, but an attention should be paid to the initial costs of materials and construction techniques, in relation to the saved amount of running costs. It should be economically feasible. For instance, the perforated panels those made of metals; painted steel; cast iron; stainless steel or cast aluminium, offer an alternative for creating original precast decorative elements that can be durable, and require less energy consumption to be manufactured, and maybe need less maintenance over time (NPCA, 2013), while their thermal efficiency is economically significant. Exploring perforated materials alternatives, technical solutions, and economic opportunities are recently constituting a great global challenge. Where the process of developing, testing, detailing and fabricating new perforated panels would not have been possible without such collaboration to offer an opportunity for material exploration and innovation that consequently allow the architect to play a greater design role (CRUSE, 2012). Dependently, the profession of architecture, including the different trends, should be transformed from viewing architecture as an art based profession to society based profession, and even to the science-based profession (Salama, 1999).

PART 2

METHODOLOGICAL APPROACH

CHAPTER 3

RESEARCH METHODS AND ANALYTICAL MODEL

3.1. The research type and research process

The research addresses a certain method of creating links and understanding the interrelations between the sustainability dimensions when designing a perforated envelope in the future. The purpose of determining the research methodology is to know how the research objectives can be achieved in a rational systematic way and in a clear sequence (Fig. 3.1). Accordingly, this research has followed an exploratory mode in its different parts.

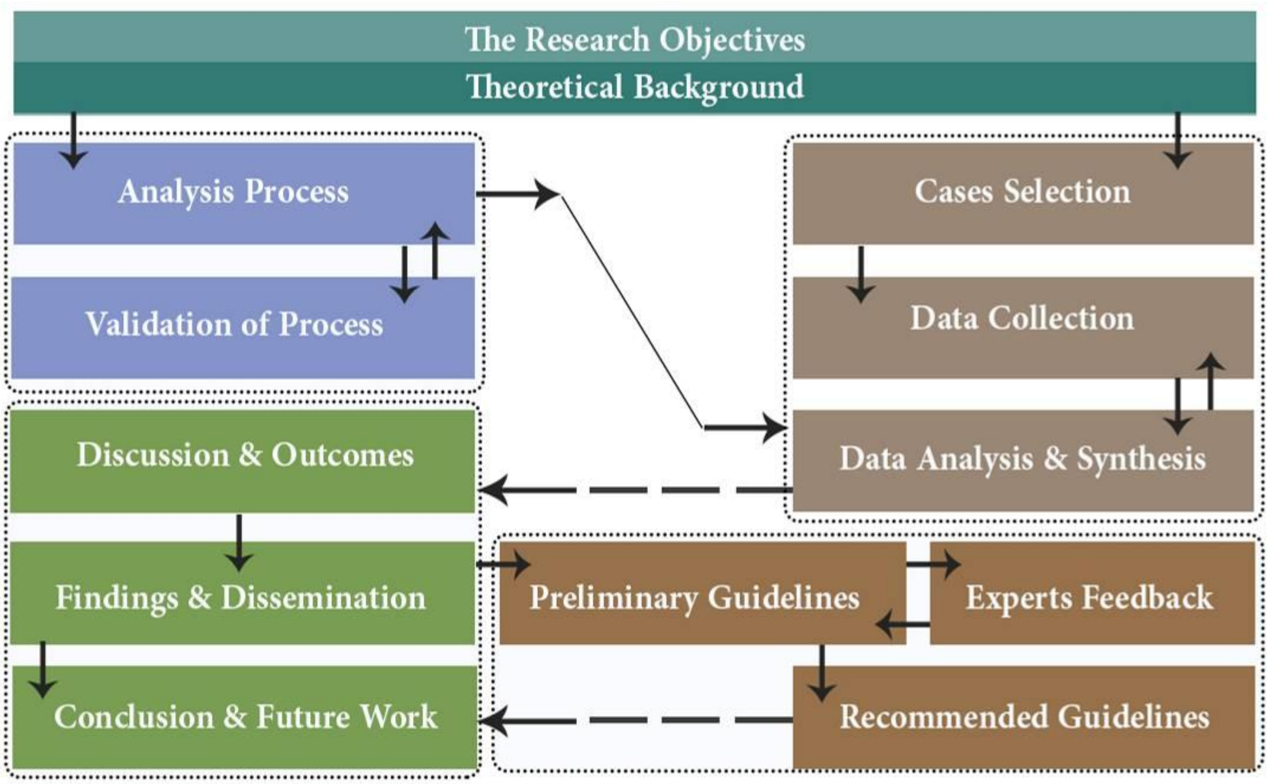

Figure 3.1: The sequence of the research process.

Both of qualitative and quantitative methods those have been followed in the processes of data collection and data analysis. These processes are structured as an analytical framework to be applied to the perforated envelopes in a sustainability point of view. A representative sample of multi-cases of contemporary perforated buildings has been selected in order to apply an analytical model framework to each case, in order to come up with reasonable outcomes those help in extracting a group of guidelines for the future designs of perforated envelopes. The guidelines can be extracted after a deep discussion of results and by interrelating the different design parameters together. Then, the guidelines are developed by getting evaluations feedbacks from different experts in this field.

3.2. Multi-cases selection criteria

The case study method is used as an empirical inquiry to investigate the contemporary phenomenon of perforation within its real-life context. There are many cases of contemporary perforation since this trend is global, and they are increasing day by day. A large sample of perforated buildings has been collected randomly from all over the world (more than 250-300 cases). Then the sample has been minimized by selecting a representative smaller sample, following certain criteria as follows (Fig. 3.3):

1- The selection considers only cases those has been dated starting from the beginnings of the 21st century as the research focuses on the most recent works. Except for one case, it has been dated to the 20th century, but it was selected since it is an important and globally famous case, which has the characteristics of the contemporary trend (Institute of the Arab World, Paris).

2- The selection considers only implemented cases, as the analysis intends to focus on implementation challenges and context features, in addition to the consideration of initial and running costs, the used technologies, the used materials, maintenance issues, etc.

3- The selection considers only documented cases as textually well-described and graphically illustrated using images, drawings, and details. The documentation sources can be journals, magazines, architectural websites, Google maps and street views. Documentation is very important, in order to get the sufficient needed data for doing the analysis. Otherwise, the selected cases can't be precisely analyzed.

4- The climate is a significant aspect of the process of sustainable design. Accordingly, and to investigate the effects of climate on the perforated envelope design, the cases were selected from different climatic zones regarding the percentage of cases in each climatic zone (Fig. 3.2). Polar and continental climatic zones have very few percentage of cases (about 3% for each) in comparison to the total number of surveyed cases, while the temperate zone has the highest percent (69%), then the dry and tropical zones (25%). Due to this, polar and continental climatic zones were excluded from the selection. Successively, 43 cases were selected from the temperate climatic zone, and 17 cases were selected from the tropical and dry climatic zones. These exact numbers constitute about 51% of the total cases in each climatic zone after doing criteria 1, 2, 3.

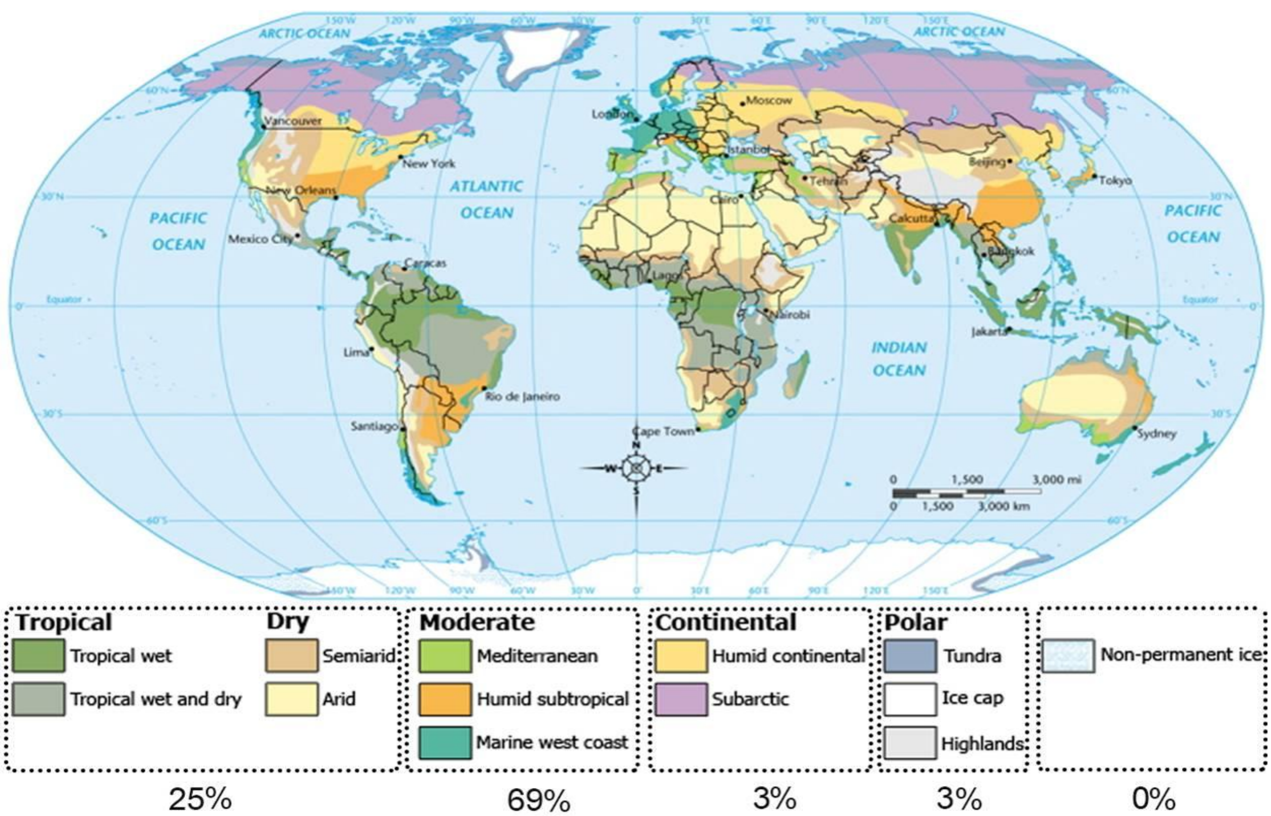

Figure 3.2: Cases percentage in each climatic zones, <https://commons.wikimedia.org/wiki/File:ClimateMap_World.png>, *(03/2015), edited by the researcher.*

5- After specifying the number of selections (60 cases), it is important to distribute those selections regarding the categories of building use. Two categories were determined: a) public buildings (commercial, educational, cultural, offices, et.), and b) residential buildings (houses, villas, apartment buildings, etc.). The distribution followed the percentage of each category to the total number of surveyed cases: 68% public buildings and 22% residential buildings, which means 41 cases of public buildings and 19 cases of residential buildings.

6- When distributing the selections, also the context where the building is located (urban, suburban, rural) was taken into account. Accordingly, and regarding the percentage also, they were distributed as 29 cases from urban contexts, 22 cases from suburbs, and 8 cases from rural contexts.

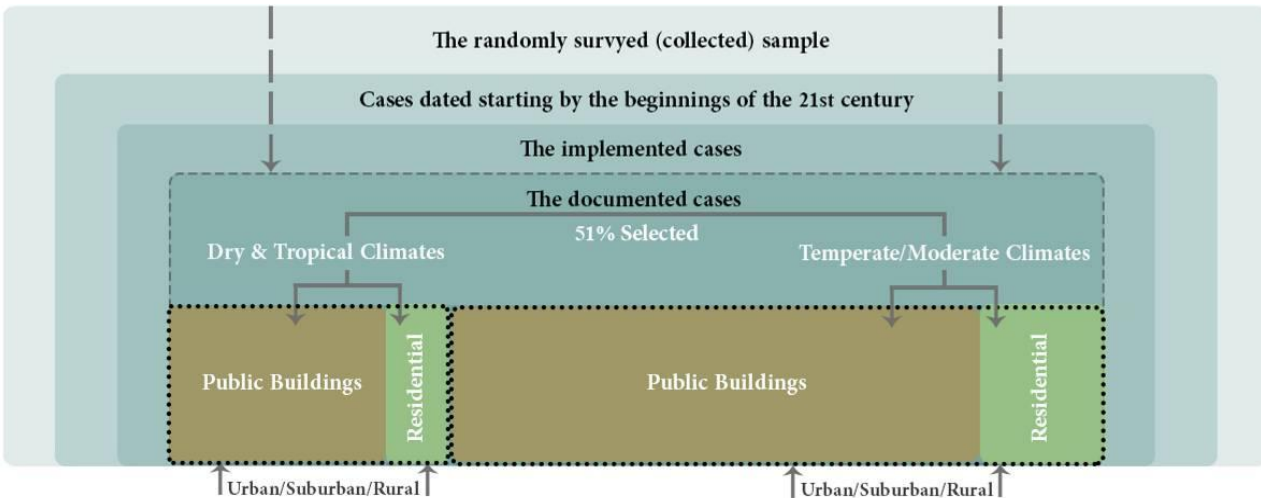

Figure 3.3: The sequence of selection criteria.

The sixty selected cases were listed in a descending order regarding the building's use categories (public and residential) as follows:

The selected public-use buildings					
No.	**Project Name**	**Location**	**Use**	**Dates**	**Designer**
1	Ornans Infant School	Doubs - France	Educational	2014-2015	Lewis & Loizeau
2	Umimirai Library	Kanazawa-Japan	Educational	2011	Coelacanth K&H
3	Saint Joseph University	Beirut-Lebanon	Educational	2011	Y.Tohme&109 Architects
4	School Extension, Ganduxer	Barcelona-Spain	Educational	2013	Pich-Aguilera
5	School in Cambodia	Sra Pou, Cambodia	Educational	2010-2011	Rudanko& Kankkunen
6	Institute Du Monde Arab	Paris - France	Cultural	1981-1987	Jean Nouvel
7	Seville Ceramics Museum	Seville-Spain	Cultural	2009-2012	AF6 Arquitectos
8	Rapperswil-Jona Municipal Museum	Zurich-Switzerland	Cultural	2007	Biel / Bienne, Mlzd
9	Lille Metropole Modern Art Museum	Lille, France	Cultural	2010	Manuelle Gautrand
10	Polish Pavilion, Expo 2010	Shanghai-China	Cultural	2010	WWAA
11	Danish Pavilion, Expo 2010	Shanghai-China	Cultural	2010	BIG
12	Russian Pavilion, Expo 2010	Shanghai-China	Cultural	2010	P.A.P. ER
13	Fraunhofer Transfer Centre	Darmstadt, Germany	Cult-Education	2010	JSWD Architekten
14	San Telmo Museum Extension	Madrid-Spain	Cultural	2011	Nieto Sobejano
15	Kolumba Museum	Cologne-Germany	Cultural	2008	Peter Zumthor
16	ModernaMuseet Malmö	Malmö-Sweden	Cultural	2008-2009	Tham&VidegårdArkitekter
17	Museum of Archaeology	Seró-Spain	Cultural	2012	Toni Girones
18	Le MuCEM	Marseille-France	Cultural	2013	Rudy Ricciotti
19	Islamic Museum of Australia	Melbourne-Australia	Cultural	2014	Desypher
20	Leiner Furniture Store	Innsbruck-Austria	Commercial	2012	Zechner
21	L'Atoll Angers	Angers-France	Commercial	2012	Antonio Virga & AAVP
22	Dubai Tower "O - 14"	Dubai-UAE	Com-Offices	2006-2012	RUR – Reiser &Umemoto
23	Trollbeads Jewelry Building	Copenhagen-Denmark	Commercial	2014	BBP Arkitekter

No.	Project Name	Location	Use	Dates	Designer
24	Lightmos Company	Bangkok-Thailand	Office Building	2006-2008	Architectkidd
25	The Orange Cube	Lyon-France	Office Building	2005-2011	Jakob& Macfarlane
26	U15 Office Building	Milano-Italy	Office Building	2011	Cino Zucchi
27	Company Building in Kanagawa	Kanagawa-Japan	Office Building	2014	HMA Architects
28	CAP Progres Raval de Badalona	Badalona-Spain	Office-Medical	2009-2011	Jordi Badia Rodriguez
29	Plescop City Hall	Plescop-France	Office Building	2012	L'hyver-Brechet-Lohé
30	Extension of City Hall of Illkirch	Illkirch-France	Office Building	2014	Atelier Filippini
31	Edogawa Garage Club Renovation	Tokyo-Japan	Industrial	2009	Jun'ichi Ito & Associates
32	Incineration Line Building	Roskilde-Denmark	Industrial	2014	Erick Van Egeraat
33	Raas Hotel	Jodhpur-India	Recreational	2011-2012	Lotus Praxis Initiative
34	Caldor Hotel	Seedörfl-Austria	Recreational	2009	Söhne & Partner
35	Al-Ghanim Clinic	Kuwait	Medical	2014	AGi Architects
36	Torre de Especialidades Hospital	Mexico City-Mexico	Medical	2013	Alison Dring
37	Khmeresque Temple	Batambang-Cambodia	Worship	2014	Archium & Kim
38	KAPSARC Mosque	Riyadh- KSA	Worship	2014	HOK
39	Step Up 5th Centre	Santa Monica-USA	Community	2009	Brooks & Scarpa
40	Community Centre, Seden	Sedan-France	Community	2009	Philippe Gibert
41	Childcare Centre	Tourrette -France	Community	2013	Heams & Michel
		The selected residential use buildings			
42	Mashrabiya House - Jerusalem	Jerusalem-Palestine	Residential	2011	Senan Abdelqader
43	Masdar City Residences	Masdar-UAE	Residential	2006-2025	Foster & Partners
44	28th Street Apartments Extension	Los Angeles-USA	Residential	2012	Koning Eizenberg
45	House (Abbink X de Haas)	Amsterdam-Netherland	Residential	2007-2012	Chris Kabel
46	B+B House	Sao Paulo-Brazil	Residential	2014	Studio MK27
47	Villa Kavel 01	Amsterdam-Netherlands	Residential	2014	Studio nine dots
48	Rue des Suisses Apartment Buildings	Paris-France	Residential	2012	Herzog & De Meuron
49	House in Cape Town	Cape Town-South Africa	Residential	2014	Three 14 Architects
50	Stereoscopic House	Singapore	Residential	2012	Pencil Office
51	House K	Palestine	Residential	2012	Auerbach Halevy
52	Termitary House - Celosía de ladrillo	Da Nang-Vietnam	Residential	2014-2015	Marta Mompó García
53	Agbaria House	Haifa- Palestine	Residential	2011	Ron Fleisher
54	4 Houses - KSA	Jeddah-KSA	Residential	2014	Dom Arquitectura
55	Concrete House	Tal Arabee'- Palestine	Residential	2014	Pitsou Kedem
56	Ngamwongwan House	Bangkhen-Thailand	Residential	2014	Junsekino
57	Casa PetriniVillani	Polignano a Mare-Italy	Residential	2008-2011	Antonella mari
58	Daily Dream Home-Harold Street	Melbourne-Australia	Residential	2012	Jackson Clements Burrows
59	Local House	Saint Kilda-Australia	Residential	2014	MAKE Architects
60	Kahrizak Residential Project	Tehran, Iran	Residential	2015	CAAT Studio

Table 3.1: List of the selected case of contemporary perforated buildings.

The list shows that none of the selected cases is located in Egypt or the North African countries in spite of the dramatic presence of the traditional perforated models there. This because the surveyed sample has shown a sort of harmonious continuity of the traditional perforated elements -in some circumstances and in different cases- with no clear significant design change or formative leap as it was in the cases of other geographical regions, except in some very few cases those don't indicate a reasonable change to be considered in the selection process. Nevertheless, the chronological comparative study was mainly basing on the traditional perforated models in those countries.

3.3. Cases description criteria

The selected cases were described (as shown in the appendices) depending on their documentations those have been collected directly and indirectly from different sources, following what has been mentioned by designers, and following the illustrative maps, images, drawings, details, etc. The description criteria have a specific curriculum including three parts:

a) Textual information: as a short paragraph that describes and indicates the main information about the building design strategies, technologies, materials, the designer intentions of creating the perforation, and other concepts, awards, etc. The textual information is considered important to realize the contextual reasons beyond the design concepts. Textual information is considered as the first base for getting the needed data for the analysis phase.

b) Structured information: as tabulated data indicating the building's location, implementation date, use, height, its geographical contexts, and its site topography (Table 3.2).

As for the site topography and the site context, they were determined in regards to the building location, by using Google map tools. The number of floors is directly gotten from the architectural drawings or the building textual description, and so on for other information in the table.

Building location:	Country-City	Architect/s:	Designer/Institution	Site topography:	Mountainous / Hilly / Flat
Construction date/s:	Year (from-to)	Site context:	Urban / Suburban / Rural	Climatic zone:	Moderate / Dry / Tropical
Building use:	Public /Residential	Users group:	Gender-Age	Floors number:	1, 2,3, ….10, More

Table 3.2: The description's tabulated data.

c) Visual information: as a sort of image/s illustration for the perforated building, to graphically clarify and present the textual description and some tabulated date.

3.4. Structure of the analytical model

The analysis phase requires only the needed data which help in answering the research questions and in achieving the intended research objectives. In order to do so, and to organize the analysis process within the intended framework, a specific model of analysis has been structured and developed to be applied to each of the selected cases. The adopted model is based on the generation and interrelation of data regarding the sustainability dimensions, by getting a set of indicators those help in analyzing the perforated envelope. The proposed model has been developed also following a certain clear method (3.4).

The analytical model can be applied in the future, during the design phase of a perforated envelope, as an early phase before implementation, to make a pre-occupancy assessment. Dependently, in that phase, no great need for getting direct feedbacks from the buildings occupants, the most needed is information about the user's needs and local community characteristics. While the occupant's feedback is crucially needed in making a post-occupancy assessment, which is not included in the limits of this research. It can be developed in another model which needs other extended works in the future.

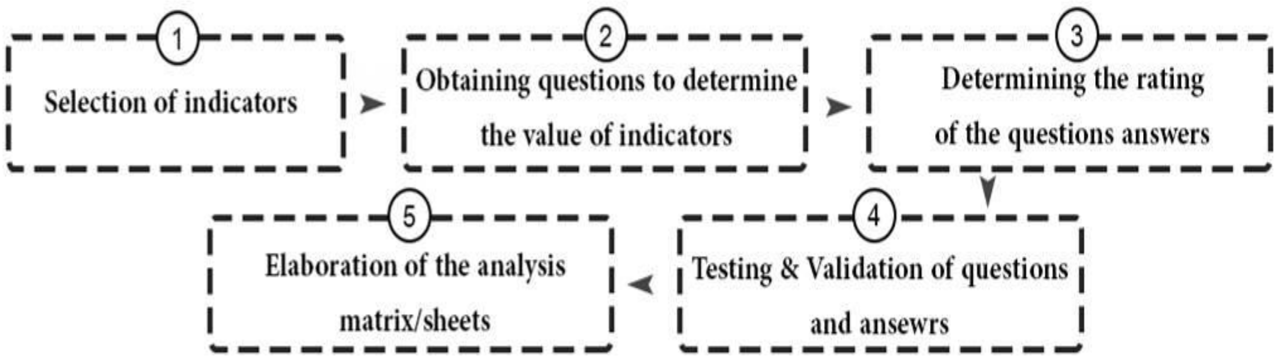

Figure 3.4: The development phases of the analysis model.

3.5. Analysis indicators and rating

The analytical model relies on four main components: a) the technological component which is related to the construction and perforation technologies and techniques, b) the environmental component, c) the socio-cultural component, d) the economic component. Where each component has some indicators to be analyzed using them. These indicators have been used as a sort of questions and answers, as they can be directly clarified and interrelated to each other. The analytical model is limited to the building's envelope level, and only to the perforated envelopes. Accordingly, the analysis focuses on only the aspects those are related to perforation and sustainable perforated envelopes, by using measurable or accessible indicators.

To structure the analytical model, the tangible environmental, social, and economic indicators have been determined based on the global sustainability assessments. Dependently, the collected or analyzed data about indicators are structured into tables (matrixes), following their specific component.

3.5.1. Technological indicators

The technological component (perforation and construction parameters) helps in building a database for the analysis to be a reference for conducting the relationships and interrelations between the different components of the envelope and to determine its ability to sustain. The technological component includes both of the perforation and the construction parameters in a sort of questions and answers (Table. 3.3), they are clarified as follows:

Technological data of the perforated envelope									
Construction & perforation parameters									
Question		Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Table 3.3: The technological data of the perforated envelope, where Q: question.

<u>Question (1):</u> What is the type of intervention of the perforated envelope? It determines if the perforated layer or the perforated envelope has been added to the building later on, or it was implemented concurrently with the building from the beginning. The answer should be clearly as “Newly added” or “Previously built”, according to what has been mentioned in the textual documentation.

<u>Question (2):</u> What is the number of the perforated faces/facades? It is directly answered by how many perforated faces/ facades are existent in the building envelope, regarding the project images and drawings.

Question (3): How many façades are fully-perforated? Fully perforated means that the perforation has been distributed to all/most of the façade/face area (approximately 75% or more). Consequently, the partially perforated façade/face means that the perforation is used in a limited area of the façade/face (approximately 25% or less). The answer here is about counting the number of fully-perforated façades, which implicitly gives the number of partially-perforated ones when they are subtracted from the total number of perforated facades (Q2).

Question (4): What is the orientation of the perforated faces? The answer indicates all the orientations of all the perforated facades in the building. For example, if there are two perforated facades, one oriented to the north, and one to the west, the answer will be N, W. The reference of answers is the project drawings or the building's location on Google maps.

Question (5): What is the shape of the perforated faces of the envelope? One or several shapes can be mentioned here as: Flat shape \ Irregular shape \ Folded shape \ Curved shape \ Inclined shape \ Various shapes \ Others shapes. When the answer is not included in the selections, then the shape is indicated instead of the world "other shapes". If a building has different shapes of facades, it is answered by selecting "Various shapes".

Question (6): What is the number of perforated layers in the envelope? It is answered by counting the number of perforated layers depending on the building sections, wall details, or the textual information.

Question (7): What is the type of roof perforation? If the roof is perforated, then the answer indicates the type of the perforated roof as Perforated domes \ Flat roof \ Inclined roof \ Others \ Not perforated. When the answer is not included in the selections, then the roof type is indicated instead of "others".

Question (8): What is the type of perforated material? The options are Wood \ Concrete \ Metal \ Stone \ Earth \ Others. When the answer is not mentioned in the options, or if the perforated layer has different materials, then the material/s type/s is indicated instead of "others".

Question (9): How was the perforation created? A facade, surface, or panel perforation can be created by two methods: interlocking/weaving blocks (i.e. concrete blocks, reeds, stones, etc.) by leaving spaces between them to create the perforation, or by drilling the surface to leave multiple holes those shape the perforation.

Question (10): What is the type of material behind the perforated layer? The question is valid for double-skin envelopes. The options are Wood \ Concrete \ Metal \ Stone \ Earth \ Glass \ Others \ NA. When the answer is not included in the options, or if that layer has different materials, then the material/s type/s is indicated instead of “others”. If the envelope is single-skin, then the answer is “NA: not applicable”.

Question (11): What is the perforation pattern shape? The answer reference is that: the primitive geometrical pattern is any array of the primitive shapes (circles, ellipses, rectangles, squares, rhombuses, polygons, triangles, etc.); the floral pattern is an array of plants decorations (i.e., such as leaf shape); symbolic pattern is any pattern which was created by the designer to symbolize a certain idea or identity; irregular pattern is the pattern that has no order; and “others” can be replaced by types those are not included in the options.

Question (12): What is the perforation approximate sizing? It means the approximate size of each single hole within the perforation pattern, the answer is one of the following: very tiny-sized \ small-sized \ large-sized \ variant sizes. Where very tiny-sized indicates that the hole’s largest width \ diameter is less than the human forehead scale (150mm). Small-sized indicates that the hole’s smallest width/diameter is within the human forehead scale (150mm) and up to the vertical scale of the human face (230mm). And large-sized indicates that the hole’s smallest width/diameter is more than the vertical scale of the human face (more than 230mm) (Fig. 3.5).

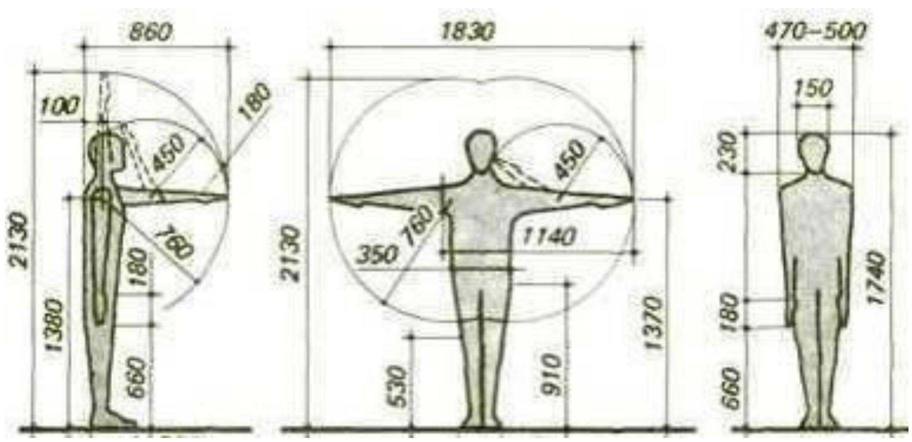

Figure 3.5: The human forehead and face scales, <https://it.pinterest.com/pin/519180663271346157/>, (04/2015).

Question (13): What is the configuration type of perforation? It represents the order which has been followed for distributing the holes within the perforated surface as Regular arrays \ Irregular arrays.

Question (14): What is the approximate perforation ratio in each face? The perforation ratio is calculated for each case using the digitizing tools of AutoCAD software and Photoshop software, by tracing the image/drawing of the façades/faces in each case. Calculating the unperforated areas in the facade is easier than calculating the perforated ones, the unperforated area can be subtracted from the facade gross area to get the perforated area. Then calculations continue to solve the equation (Fig. 3.6).

The results have been grouped into approximate intervals as 1-10%, 11-35%, 36-50%, over 51%. An additional option "Variant" is used for indicating that different facades of the same building have very different perforation ratios. Furthermore, in the case of partially perforated facades, the perforation ratio is calculated similarly, but by considering the perforated panel gross area instead of the facade gross area (Fig. 3.7).

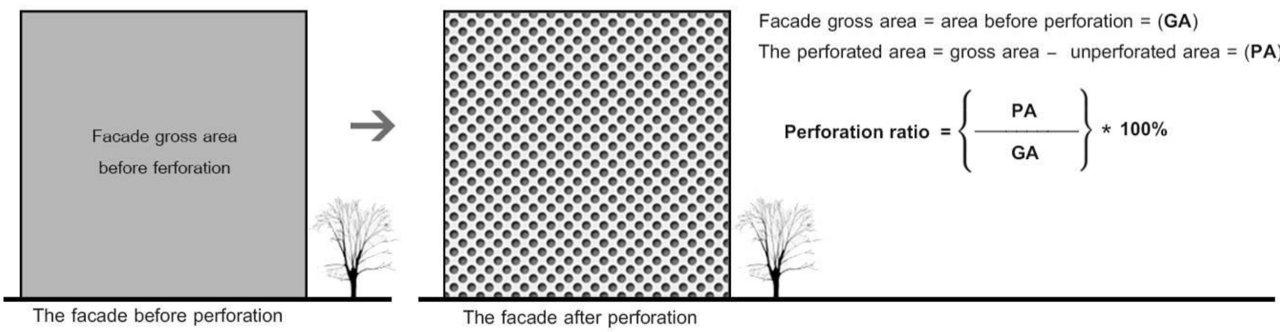

Figure 3.6: Method of calculating the facade perforation ratio.

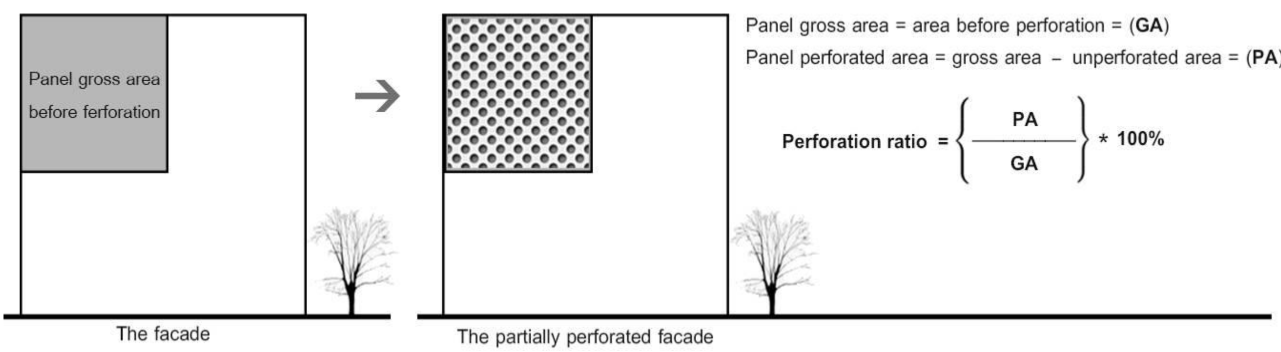

Figure 3.7: Method of calculating the panel perforation ratio.

Question (15): What is the approximate thickness of the perforated layer? Regarding architectural drawings, details, or textual description, the perforated layer thickness can be estimated or approximated to the following rating groups:1- 9 mm \ 1-5 cm \ 5-30 cm\ Over 30 cm \ Variant. Where, for example, 1-9mm includes thin metals, 1-5 cm includes thick metals and woods, and so on.

Question (16): What is the approximate depth of air cavity? This question is valid for double-skin envelopes, which indicates the depth of the space between the two layers of the double-skin. The answer options are grouped according to the human body scale (Fig. 3.5) as: <0.59m \ 0.60-1m \ Over 1m \ Variant \ NA. Where, 1-0.59m doesn't fit the human scale, 0.60-1m fits exactly the human scale, and over 1m suitably fits the human scale. In the case of the single-skin envelope, the answer is "NA: not applicable".

Question (17): Does the perforated layer have open-able elements? This question is valid for both partially and fully perforated facades. The openable elements can be windows, doors, foldable panels or sliding panels those can be opened upon occupants' need. Where the answers "few" indicates two openable elements or less, with a gross size less than a quarter of the facade.

Question (18): For partial perforations, are there windows beside perforation? This question is answered similarly to the Q. 17, but for partially perforated facades. To know if the partial perforation is the only area for ventilation or daylight, etc., or there are other windows/openings in the same facade/face.

3.5.2. Environmental indicators

The building envelope is expected to ensure the environmental balance between inside and outside the building, where its effective successful design produces energy-efficient buildings with efficient environmental qualities and positive environmental impacts. To introduce a design of an energy efficient envelope, a set of indicating parameters should be taken into consideration in both passive and active design techniques, such as orientation, materials thermal capacity, energy saving, technology, insulation, glazing, surface reflectance, heat absorbance, daylight transmission, view-ability, natural ventilation, etc. These parameters change the performance of the building envelope. Dependently, the envelope's environmental design has some parameters those indicate both passive and active techniques for enhancing the envelope's environmental performance (Table 3.4).

1. *Indicators of envelope's passive design*

The successful passive design of buildings decreases the energy use, which means decreasing the energy costs. Also, it increases the occupant's comfort on the visual level, acoustical level, thermal level, etc. Key aspects of passive design include appropriate orientation, appropriate ventilation (passive cooling), appropriate windows placement, balancing the daylight transmittance, considering and selecting appropriate materials in regards to their properties (i.e. resisting humidity and moisture, thermal capacity, permeability, rigidity, durability, etc.), and other passive design techniques. Those parameters of passive design indicate to what extent the design of an envelope is passive. They were included in the analytical model as a sort of questions (Table 3.4) as the following:

Environmental indicators of the perforated envelope							
Passive design parameters							
Question		**Answer options**					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				
Active design parameters							
Question		**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			

Table 3.4: The environmental indicators of the perforated envelope, where Q: question.

<u>Question (19):</u> What is the designer's intention of creating the perforation? The answer is related to what has been mentioned in the textual information if the perforation concept is: Environmental\ Social \ Economic \ Aesthetic \ Conceptual \ Others. Where "others" can be replaced by the intentions those are not included in the answer options. When the designer has multi intentions, then multi-options can be chosen.

Question (20): What is the purpose of orientating the perforated facades? The answer is also related to what has been mentioned in the textual information, if the designer has oriented the perforated facades as Environmental orientation \ Conceptual orientation \ Inevitable orientation \ Orientation is not considered \ Others. Where “others” can be replaced by purposes those are not included in the options. When the designer has multi purposes of orientation, then multi-options can be chosen.

Question (21): What is the facades’ daylight transmittance ratio (openness)? The ratio has been calculated by considering the perforated areas and other envelope’s void areas (such as windows, glazing, doors, etc). The answer options are grouped in certain intervals in order to make an approximation for several calculation results, as 1-10% \ 11-35% \ 36-50% \ Over 51% \ Variant ratios. The option “Variant ratios” is used for indicating that different facades of the same building have very different openness ratios. For fully perforated facades, the openness ratio equals the perforation ratio (Q14), while for partially perforated facades the ratio is calculated similarly to Q14 but by considering all the facades openings area (perforations and other voids) (Fig. 3.8).

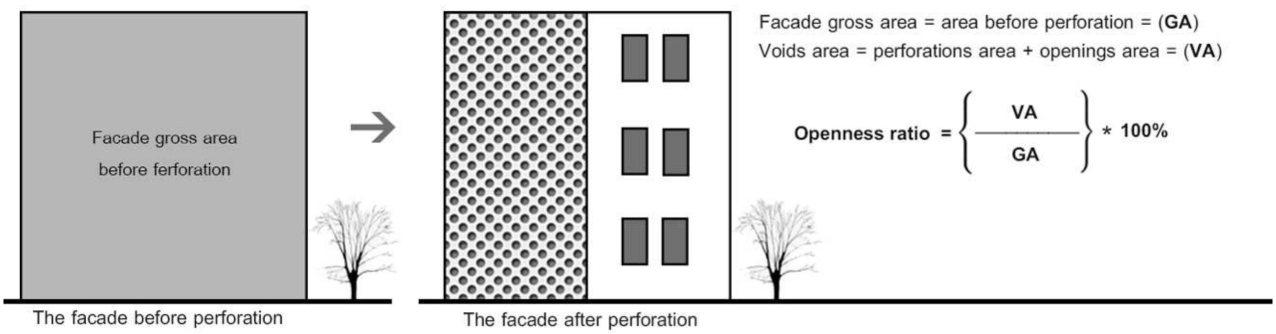

Figure 3.8: Method of calculating the openness ratio.

Question (22): Does the envelope’s design consider the passive cooling and natural ventilation? The question can be answered as Yes \ No, depending on the used techniques for ventilation (wind-catchers, chimney, ventilated facade, manually-moving dynamic envelopes/panels/elements, etc.).

Question (23): What is the perforated material’s source category? The perforated material can be categorized as: Conventional material (wood, earth, stone, reeds, bamboo, etc.) \ Modified conventional materials \ Man-made common materials (metals, glass, polymers, concrete, etc.) \ Man-made materials but they are considered as innovative or modified to resist the local climatic conditions \ Variant materials.

Question (24): What is the level of perforated material's thermal capacity? It depends on the material conductivity value, its thickness, and density (heat transfer time). Where conductors have the low thermal capacity as the heat transfer is quick. Non-conductors with thin layers and semi-conductors have the moderate thermal capacity, as the transfer of heat is slower than conductors. And non-conductors with thick layers have the high thermal capacity as the heat transfer is slow. "NA: no answer" is used when the used material is innovative and there is no information about its properties (Table. 3.5).

Category	Material	Thermal capacity	Conductivity / heat absorption	Moisture / humidity resistance	Relative costs
Concrete	Masonry units / concrete blocks	High	Low	Moderate	Low
	Sand/cement screed	High	Low	Moderate	Low
	Cast-in-situ	Moderate	Low	Moderate	Low
Metals	Aluminium	Low	High	High	High
	Copper	Low	High	High	High
	Iron/ cast iron / steel	Low	High	Moderate /if treated	Moderate
	Stainless steel	Low	High	High	High
	Titanium	Low	High	High	High
Brick	Common brick	High	Low	Moderate	Low
Woods & organic materials	Hard woods	High	Low	High	Moderate
	Bamboo	High	Low	Moderate	Moderate
	Reeds	Moderate	Moderate	Moderate	Moderate
	Rice husk	Moderate	Moderate	Depends on composition	Moderate
	Straw balls (with bricks)	Moderate	Moderate	Depends on composition	Moderate
	Plywood	High	Low	High	Moderate
Cement	Ferro-cement & Aerocon panels	High	Low	High	Low
	Fibre-cement composites	High	Low	Moderate	Low
	Fly ash bricks	High	Low	High	Low
Earth	Mud blocks (compressed)	High	Low	High	Low
Glass	Single-glazing	Low	High	High	Low
	Double- glazing	Moderate	Moderate	High	Moderate
Ceramic	Ceramic tiles / blocks	Moderate	High	Moderate	High
Plastic	Thermoformed plastics	High	Moderate	High	Moderate

Figure 3.5: Properties rating of building materials, in regards to their relative values (collected from deferent sources).

Question (25): Does the perforated layer have insulations? Depending on the drawings, details, and description, it can be answered if the perforated layer has thermal insulation or waterproof, both of them, or no insulations are used. When the answer is "Yes", then the insulation type is specified in the answer. "NA: no answer" is used when the information has no evidence if there are insulations or no.

Question (26): Does the layer behind/front the perforation have insulations? It is similar to Q.25, but applicable for the layer behind or in front of the perforated layer.

Question (27): What is the proportion of hole's size to the perforated layer thickness? The hole size is its average approximate width \ length \ diameter, which is compared in its proportion to the depth of the perforated layer. This means how much shading/shaded areas does the perforated layer provide.

Question (28): What is the level of material's resistance to moisture and rain? The answer follows the rating in table 3.5, where the rating was determined according to the porosity, permeability, hardness, and durability of the material. "NA: no answer" is used when the information has no evidence to the material resistance.

Question (29): Does the perforated layer help in decreasing the heat transfer? The position or performance of the perforated layer can be sometimes changeable to follow occupant's needs, such as opening/closing the perforated layer, panel, the perforation holes, changing angles and orientations, intersecting perforated layers, etc. in order to decrease the direct exposure to sunlight. Accordingly, answer options can be: Yes: specify how (i.e. changeable orientation) \ Slightly (i.e. partially changeable components of the perforated envelope) \ No (i.e. fixed envelope's position \ NA (no answer related to this point).

Question (30): Are there other used passive design techniques/elements? If applicable, it is worth to know if there are any other passive design solutions or techniques (i.e. wind catchers, ventilated facades, living walls, pneumatic materials, etc.) those are working alongside with the perforations within the building envelope to increase its thermal performance and its environmental effectiveness. If so, the solution has to be specified in the answer in order to discuss its role.

2. *Indicators of envelope's active design*

The active design uses different types of equipment to modify the building's environmental efficiency and to maintain occupant's thermal comfort, acoustical comfort, and visual comfort, etc. Active design of building's relies on using mechanical devices (such as fans, air-conditioning, artificial lights, pumps, control machines, etc.) to adjust the occupant's comfort levels in different ways. Accordingly, the active design has some parameters those indicate to what extent the design relies on active techniques. They were included in the analytical model as a sort of questions (Table 3.4) as the following:

Question (31): What is the way of opening/moving the envelope's elements? If the perforated envelope has some moveable elements such as windows or kinetic panels, or if the envelope itself is dynamic, since it is important to know how they move. In the answer options: "smart" indicates the use of remote sensation and Nanotechnology, etc., and "others" is replaced by any other option when the suitable answer is not included in the options.

Question (32): What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels? If applicable, the energy norm should be indicated as renewable, or non-renewable. Otherwise, if the envelope is not dynamic or manually controlled, then the question is not applicable "NA".

Question (33): Does the envelope's design enhance the energy-saving? This question includes passive and active designs, but it is inserted here in order to be derived from the set of questions. The options are selected clearly by Yes \ Slightly \ No \ NA. Where "slightly" indicates that the enhancement is limited to the active design techniques.

Question (34): Does the perforation need technology for manufacturing? This question is related directly to Q.9, if the perforation is manually made by interlocking the blocks, then the use of manufacturing technology of perforation is not needed. While the manufacturing technology takes its place for the prefabricated perforated panels (i.e. prefabricated perforated metal sheets).

Question (35): Does the building have some awards/certificates? If yes, the focus is on mentioning what type of environmental awards, certifications (i.e. LEED), or other design awards that the project got.

Question (36): Are there other used active design techniques/elements? If applicable, it is worth to know if other active design solutions are used (i.e. including smart glazing, solar shading devices, etc.) those are working alongside with perforation within the building's envelope to increase its thermal performance and its effectiveness. If so, the solution has to be specified in the answer, in order to discuss its influential role.

3.5.3. Socio-cultural indicators

The socio-cultural aspects depend on the geography, economy, political status, and the history, while the socio-cultural indicators include a set of parameters related to how the building's occupants use the envelope to manage or enhance their comforts, how they adapt with the envelope's design, and how the design connects them with their surrounded context. The occupants' abilities of use, adaptation, and connection vary from design to design. While there are some outlined questions (Table 3.6) those can indicate how the socio-cultural aspects take their place in the design of a perforated envelope, as mentioned in the following questions (Table 3.6):

Socio-cultural indicators of the perforated envelope						
Usability, adaptability, and connectivity						
Question		**Answer options**				
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA		
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there are no openable elements?	Yes	Slightly	Not in all facades	No	NA
Q.41	In the case of double-skin, does the air cavity impede or obscure occupants' viewability to the outside?	Yes	Slightly	Not in all facades	No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No	
Q.45	In the case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No	

Table 3.6: The socio-cultural indicators of the perforated envelope, where Q: question.

<u>Question (37):</u> Does the perforation pattern indicate a cultural symbolism? It depends on the intention of the designer if he has created a symbolic perforation pattern to present and indicate a cultural identity relevance or no.

<u>Question (38):</u> Is the perforated material commonly used by the community? Answering the question needs a quick look at Google street views and some readings about the local common used materials in the buildings' envelopes there.

<u>Question (39):</u> Is the air cavity accessible for building's occupants? If applicable, it is related to Q.16, the air cavity depth must fit the human scale, and then it must be reachable by occupants. In some cases, it can be just a technical cavity and has no horizontal connections with internal spaces (non-reachable). Information to answer the question can be gotten from drawings, details, and images, etc.

<u>Question (40):</u> Does the perforation sizing impede or obscure occupants' view-ability to outside, if there are no openable elements? It is related to Q.12, where "yes" is related to the very tiny-sized perforations, "slightly" is related to the small-sized perforations, and "no" is related to the large-sized perforations. "NA" indicates the invalidity of the question, due to the existence of windows or open-able components within the envelope.

Question (41): In the case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside? It is related to Q.39. In the case of the inaccessible cavity and not open-able skin parts, the answer is "yes". In the case of inaccessible cavity an open-able skin parts (or vice versa), the answer is "slightly". "No" means no impedance or obscurity.

Question (42): Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade? If the distribution of the perforation is concentrated on certain zones of the facade or no. Where "slightly" means that the solid zone ratio is approximately 25% or less of the facade.

Question (43): Does the perforation's configuration increase visual privacy? It is related to Q.14, 27, 40. Where "Yes" means that the perforation sizing is very tiny-sized perforations or the perforated layer thickness is larger than the perforation sizes. "slightly" indicates the small-sized perforations with a glazed layer behind, and "no" indicates the large-sized perforations with a glazed layer behind.

Question (44): Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope? The answer depends on Q.14, 27 and the sound theory, where the small pores increase the sound absorption and the fading of sound waves. Then the answering criterion is similar to Q.40, but adding to the "slightly" option that it can be chosen also in the case of large-sized perforations with a layer depth of more than the hole size or equals.

Question (45): In the case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons? It depends on the accessibility of the air cavity, "yes" indicates the inaccessible wide air cavity (more than 1m) which impedes or obscures the occupants' verbal contact with outside persons. Where "slightly" indicates the inaccessible cavity with an approximate depth of 0.61-1m. And "no" means that the air cavity is accessible or has a depth of less than 0.61m.

Question (46): Does the perforation increase the physical security? For rigid/hard materials and deep perforated layer, the answer is "yes" as they increase the security. Also for a thin perforated layer, it increases security "slightly". For very large-sized perforations (close to a window size) with a glazed layer behind, no significant role in increasing the physical security.

Question (47): Does the perforation increase the occupants' visual privacy? It is an accumulative question, related to Q.14, 27, 40, 43, 44. Where "Yes" indicates that the perforation sizing is very tiny or the perforated layer thickness is larger than the perforation sizes. "slightly" indicates the small-sized perforations with a glazed layer behind, and "no" means large-sized perforations with a glazed layer behind.

3.5.4. Economic indicators

The economic indicators include a set of parameters those are related to the initial costs of perforation's construction and their effects on the running costs of the building. In addition to the maintainability issues of the perforated envelope. Therefore, there are some outlined questions to indicate how the economic aspects take their place in the design of a perforated envelope, as the following (Table 3.7):

Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What are the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the bird's nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Table 3.7: The economic indicators of the perforated envelope, where Q: question.

Question (48): What are the perforated material's relative initial costs? The answer options are based on the information those included in the table (3.5).

Question (49): Does the perforation technique have independent costs? It is related to Q.9 and Q.34, where the prefabricated drilled panels need an independent technology to create them, which means independent costs. While the interlocking blocks those can be shaped on-site manually have no independent costs.

Question (50): Does the dynamism of the perforated layer have running costs? If the perforated envelope is dynamic, kinetic or open-able by using electro-mechanical equipment or machines, then it has running costs of energy use and maintenance. While the manually dynamic or open-able envelope has no running costs of energy use.

Question (51): Do the perforations decrease the building's running costs? It depends on Q.20, 21, 22, 24. If the envelope's perforations enhance the daylight transmission, the natural ventilation, and decreases thermal transmittance then it decreases the running costs of the needed mechanical ventilation, artificial lighting, and mechanical heating or cooling. "slightly" means at least one of the mentioned issues is achieved.

Question (52): Is the perforated material considered as durable? If the material resists humidity, moisture, thermal expansion and climatic changes, then it is durable. If it resists at least one of them, then the answer is "slightly" (Q.24,28).

Question (53): Is the perforated material locally available? It is related to Q.38. where the local availability of materials helps in decreasing the material's importing costs.

Question (54): Is the rain penetration considered in the envelope's design? The answer depends on the detailed drawings and textual information about the used technical solutions, if available.

Question (55): Is the dust accumulation considered in the perforations' design? It is related to Q.27. The large depth of the perforated layer makes dust accumulate easily. Tiny-sized perforations and small depth of the layer make the dust accumulation "slight".

Question (56): Is the bird's nesting considered in the perforation design? It is related to Q. 12, 15, 27. If the birds nesting is not technically prevented, then the large depth of the perforated layer and the small-sized perforations together increase the chance for birds roosting, and one of them can increase the chance for roosting "slightly".

Question (57): Is the perforated material recyclable? Only metals, glass, and thermoformed plastics are considered as recyclable building materials. Accordingly, the answer's option "yes" is just valid for metals, glass, or plastic materials. While "slightly" option is valid when the material is a mix between recyclable and non-recyclable materials.

Question (58): Is the perforated layer easily cleanable? The answer's criterion is similar to Q.55.

Question (59): Is the layer behind/in front of perforation easily cleanable? If the air cavity is accessible for technical issues (more than 0.61m) then "yes" it is easily cleanable. Otherwise, it is not easily cleanable and needs some special machines for cleaning. "NA" option is valid for single-skins.

Question (60): Are the perforated panels easily maintainable/changeable? The one-unit envelope is not changeable in terms of panels, where, in the case of destruction of a part means that this part can't be easily changed or reconstructed. While the panel-form envelope facilitates the changeability of its panels when a panel is destroyed or distorted.

3.6. Testing and validation of the analytical model

Testing the proposed analytical model is an important step in order to ensure that this model is valid to be used for the analysis of the sixty selected cases, and to be then generalized for the use of other architects or architecture students those have intentions of designing perforated envelopes. For this reason, the analytical model was tested regarding successive phases as in the following:

1. First phase testing, where the initial analysis sheet was discussed deeply with tutors and other qualified persons, in order to determine the suitability of its structure, the flow of questions, and the answers options (Appendix A).

2. Second phase testing, where the initially structured analysis sheet was applied to the selected 60 cases, to investigate the expected answering options, to delete insignificant or intangible questions, to rewrite some questions in a clearer way, and to add other significant related questions. Accordingly, the model was modified in order to include the rational tangible questions those indicate the performance of the envelope on the technological, environmental, socio-cultural, and economic levels.

3. Third phase testing, where the analytical model was sent to a selected number of Ph.D. candidates from three European universities (University of Palermo, Italy; Polytechnic University of Valencia, Spain; University of Minho, Portugal). These candidates were selected since they are qualified in the curricula of architectural design or sustainable architecture. The sent analysis format was accompanied by a covering letter which indicates the researcher's information and

explains the research needs and objectives (Appendix A). Also, it was accompanied by the clarification of all questions and answers, and the gathered data about the chosen case (textual, tabulated, and illustrative data) those are needed for filling of the format.

The candidates filled the analysis format using the same chosen case (Case 6: Institute of the Arab World, Paris-France), which was chosen since it is globally well-known and it was visited by most of them. Therefore, they can use both their experience and knowledge in parallel to fill the format. This phase of testing helps in determining the answering conflicts in the same question by different persons using the same criteria for the same case, in order to finally modify and refine this format.

For refinement and modifications, only the questions those have different answers from the selected candidates were listed in a table in order to make a decision of modification (Table 3.8). Other questions those have been answered similarly by all persons, or questions those were similarly answered by most of the selected persons (one different answer only) are not included in the refinement process as they are clear and the common answers are adopted.

Question	Researcher answer	Analyst 1 answer	Analyst 2 answer	Analyst 3 answer	Analyst 4 answer	Refinement/modification
Q.11	Symbolic	Symbolic	Primitive	Symbolic	Symbolic	No change
Q.12	Variant	Small-sized	Variant	Variant	Variant	No change
Q.16	<0.59m	<0.59m	Variant	<0.59m	<0.59m	No change
Q.17	No	Yes	Yes	No	No	No change
Q.18	NA	No	No	No	No	adding “NA” option
Q.36	Yes	NA	Yes	NA	Yes	No change
Q.45	No answer	No answer	No answer	No answer	No answer	adding “NA” option
Q.51	Slightly	Slightly	NA	Slightly	Slightly	No change
Q.55	Yes	Yes	NA	NA	Yes	No change
Q.56	Yes	Yes	Yes	NA	Yes	No change

Table 3.8: Third phase testing and refinement process of the analytical model.

<u>Refinements were considered as the following:</u>

- Q.11: one analyst didn’t pay attention to the conceptual explanation of the pattern shape. No change will take place for this question.
- Q.12: one analyst didn’t pay attention to that the sizing is changeable due to the dynamism of the envelope. No change will take place for this question.
- Q.16: one analyst made a clearly fault selection. No change will take place for this question.

- Q.17: there is a misunderstanding between openable elements and movable elements, which is clarified in the question's explanation, two analysts didn't pay attention towards this point. No change will take place for this question.
- Q.18: all analysts answered by "No" because the option of "NA: not applicable" was missing. Accordingly, the option has been added.
- Q.36: two analysts answered by "NA" because maybe they didn't easily find the answer, which is clear in the details. No change will take place for this question.
- Q.45: all analysts left the question without an answer because the option of "NA: not applicable" was missing. Accordingly, the option has been added.
- Q.51: one analyst didn't pay attention to the table (3.5) which includes the answer. No change will take place for this question.
- Q.55: the question is not well-documented for this case, while it can be easily deduced. No change will take place for this question.
-Q.56: the question is not well-documented for this case, while it can be easily deduced. No change will take place for this question.

Dependently, and after multiple testing, modifications, and refinements of the analysis format, the analysis sheet is valid to be obtained and used for analyzing the selected 60 cases (Appendix B). Successively, a decision can be made towards disseminating this model among architects, experts, and architecture students, so as they can use this model within their initial and the final design phases.

3.7. Results discussion method

The use of sixty questions as inputs to analyze the sixty cases produces a set of outputs for each question as a sort of charts, graphs, numbers, calculations, percent, ratios, etc. where the outputs can be qualitative, quantitative, or both of them. These outputs are discussed in a systematic sequence using the following criteria:

1. Benchmarking the outputs: which means the adoption of a reference for discussing the output of each question (i.e. considering the climatic zones as a reference for the discussion of questions/answers those are related to or changeable by the climate factors, and considering the building use as a reference for the discussion when the questions/answers are related to or influenced by the building use, and so on for the site context, topography, etc.).

2. Interrelating the inputs and outputs: which means discussing the links between questions and links between answers, in order to understand their crossing impacts, and to determine the direct and indirect relations between them. This successively lead to understanding the inverse and positive relationships between indicators (i.e. Q. 8, 10, 24 are related to each other; Q. 12, 15, 27 are related to each other; Q. 20, 21, 22, 24 are related to each other; Q. 14, 27, 40, 43, 44 are related to each other, etc.). The successful discussion is about a deep understanding of these relationships, since the sustainability is not only a sort of achieving environmental, socio-cultural, and economic dimensions separately but by strongly interrelating and matching them and their impacts together.

3.8. Guidelines extraction and development

The deep discussion of all positive and inverse relationships between the sustainable design indicators leads to a general and deep understanding of the perforation design issues and what makes a perforated envelope as sustainable. This gives the ability to extract a set of guidelines those can be followed in the future designs of perforated envelopes, which constitutes the research main objective. Each guideline was connected to the other, in order to identify their relationships and intersections.

In order to develop the set of extracted guidelines, and to be sure that each guideline is suitable, significant, or insignificant, etc., a questionnaire was designed to capture the visions and feedbacks of specialists and experts in the topic of envelope's perforation, in order to verify through their practical experience how important is the impact of each proposed guidelines on the sustainability of the building's envelope, so as to properly develop these guidelines.

To facilitate the filling process, the questionnaire was designed as a sort of table including questions about each guideline's impact on the design of a perforated envelope, (Table 3.9). the questionnaire format was sent to different randomly selected experts/firms via their emails, where it is accompanied by a covering letter which explains the researcher's information and the needs to clarify the questionnaire's objectives (Appendix C).

For making a decision for each guideline, whether to obtain it or not, the received filled questionnaire formats are inserted in a table regarding the expert's answers (Table 3.10), to compare them, discuss them, exclude or discuss the strange answers, etc.

No.	Guideline for designing a sustainable perforated envelope	Guideline's impact on the perforated envelope's design			
		High impact	Reasonable impact	Low impact	No impact
G.1					
G.2					
G.3					
G.4					
G.5					
G.6					
G.7					
G.8					
G. x					
Expert notes:					

Table 3.9: Questionnaire form to get the experts feedback about the guidelines impacts.

Guideline	Expert 1 answer	Expert 2 answer	Expert 3 answer	Expert 4 answer	Expert 5 answer	Expert 6 answer	Expert x answer	Researcher Decision
G.1								
G.2								
G.3								
G.4								
G.5								
G.6								
G.7								
G.x								

Table 3.10: Questionnaire form to get the experts feedback about the guidelines impacts.

3.9. Justifications

This chapter included an explanation of the methods those have been adopted and followed in each phase of this research. While it is worth mentioning here that this type of research is not limited to these types of methods, and also theses methods are not limited to this type of research this type of research, since different methods can be adopted for the same goal, and same methods can be adopted for different research. While, the adoption of these methods, in this research, can be considered as coherent and logical in their sequence which helped in achieving the desired objectives, which in turns made the hypothesis as testable, and the results as reachable, by identifying the different related tangible variables where this search grew up depending on them.

PART 3

DEVELOPMENTAL APPROACH

CHAPTER 4

ANALYSIS OUTCOMES AND INTERRELATIONS

4.1. Geographical distribution

The phase of cases collection has a number of significant indications those worth mentioning her: Firstly, the contemporary trend of envelope’s perforation is not limited to a particular region in the world, while it has a considerable existence in Europe, followed by the Eastern Mediterranean region, the Gulf region, and the far east Asian region. No clear reason has been found beyond this phenomenon, but it is noticed that many of manufacturing companies of perforations have been emerged recently in Europe, especially in France, which might be a reason beyond the geographical distribution of the trend in some countries more than others (Fig 4.1).

Map 4.1: Geographical distribution and density of the perforation trend in the world (survey work: the researcher, original map: <https://commons.wikimedia.org/wiki/File:ClimateMap_World.png>, (03/2015)).

Secondly, the cases selection considers only cases those dated from the beginnings of the 21st century, as the research focuses on the most recent buildings. Nevertheless, almost 98% of the surveyed cases were dated after 2005, coinciding with the onset of the digital technology and the digital architecture. Perhaps this is a reason beyond the emergence of the contemporary perforation intensively starting by that period, where the digital technology has a significant contribution in facilitating the formation process of perforations within the buildings envelopes.

4.2. Analysis outcomes

Successively, and regarding the methodological approach, each question in the sixty analysis sheets has been analyzed by benchmarking and interrelating the outputs in a systematic sequence following the sheet analysis components (technological, environmental, socio-cultural, and economic categories) as clarified in the following sub-sections.

4.2.1. Technological outcomes

The technological analysis of the sixty cases, including the parameters of perforation and construction techniques, shows some significant results, as follows:

(Intervention of perforation)

Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built
		7 cases	**53 cases**

The cases selection was limited to the built works only. Dependently, the analysis sheet included clarifications of whether the perforated envelope was build coinciding with the building itself (previously built envelopes) or it has been added in a refurbishment phase after a period of time since the building was constructed (newly added envelopes).

Since the trend of envelope's perforation has new methods and appearance, therefore it is necessary to know its role in architecture, is it limited to the new buildings? or it is included in the contemporary refurbishments and retrofits of buildings to enhance their environmental, social, or economic aspects. The analysis shows that the perforated envelopes are overwhelmingly previously built (53 cases), while the other seven cases show that the perforation was also used as a method to refurbish the existing buildings envelopes, which might change the image and the function of the envelopes of some existing buildings in the near future, if the trend keeps rising.

(Number of perforated facades)

		1 face	2 faces	3 faces	4 faces	More
Q.2	What is the number of the perforated facades/faces?	**18 cases**	**6 cases**	**3 cases**	**12 cases**	**21 cases**

The results show that the obtained number of perforated facades was varying from case to case, with the two greatest focuses on the use of only one perforated facade or the use of four facades of more perforated facades in the same building, following aesthetic purposes, environmental purposes, or other purposes, as discussed in the results of environmental analysis, to clarify the role and reasons beyond deciding the suitable number of perforated facades.

(Number of fully perforated facades)

		1 face	2 faces	3 faces	4 faces	More	None
Q.3	How many façades/faces are fully-perforated?	**9 cases**	**5 cases**	**2 cases**	**9 cases**	**15 cases**	**20 cases**

The full perforation has been mostly used in all of the building's faces, or in none of them (just partial perforation), as shown above. Consequently, the partially perforated façades are used in the same numbers but perversely (when the fully perforated facades are more, the partially perforated facades are less). This is a mystery behind the reason for using fully or partially perforated facades in this way, where it is clear that no relationship between the building use category and the perforation percentage in the building's envelope, or the number of perforated facades. Where the reasons are sometimes environmental, aesthetic, etc. as clarified in Q.19, 1nd Q.20. Despite this, no evidence of climatic zone effects on the number of perforated faces of the percentage of perforation, as both of the full and partial perforations have been used in the temperate, tropical, and dry climatic zones.

(Orientation of perforated facades)

		S	N	E	W	SE	SW	NE	NW
Q.4	What is the orientation of the perforated faces?	**7 faces**	**2 faces**	**4 faces**	**2 faces**	**43 f.**	**40 f.**	**34 f.**	**31 f.**

The placement of a building and the orientation of its facades are an important step in the passive design solutions to take advantage of the passive cooling and heating, to maintain a thermal and visual comforts, etc. The results show that there are no specific signs for a particular orientation of the building perforated façades in the altitude direction, neither in the cases of the same climatic zone nor in the cases of different climatic zones, especially when all of the building's facades are perforated. This proves the inexistence of a systematic methodology of how to orient and where to locate the perforated faces. While in most of the selected cases, there was a nearly common adoption of the idea that the facade's perforation contributes in maintaining some extents of the environmental values, whatever and whereabouts the facade is located or oriented. Despite all, when the number of the perforated facades is just one or two, then they are mostly oriented towards south, south east, south west (the hottest directions).

(Shapes of the perforated faces)

		Flat	Folded	Curved	Inclined	Irregular	Twisty	Wavy
Q.5	What is the shape of the perforated faces of the envelope?	**46 cases**	**4 cases**	**6 cases**	**1 case**	**1 case**	**1 case**	**1 case**

The external surface of the perforated envelopes -whether they are previously or newly built- was shaped in a flat form in a vast number of cases (46 cases), with a few use of the curve-shaped and folding-shaped surfaces. Hence, all of the newly added perforated envelopes have flat-shaped surfaces, to fit the building's form easily.

The inclination of the building's perforated facades has no significant existence. Therefore, not only the orientation in the altitude direction but also the orientation in the azimuth direction doesn't take its role in orienting the perforated envelopes. It means that the perforation was considered by the designers either as a layer that filters and controls the sunlight passage with no need for orientation or as a layer that is designed only to add aesthetic or conceptual values to the building's envelope.

(Number of perforated layers)

		1	2	More
Q.6	What is the number of perforated layers in the envelope?	**56 cases**	**3 cases**	**1 case**

In a building's environmental design, architects have constantly to pay their attention towards the sun. The sun is sometimes harmful as well as sometimes useful for a building, as the too much sunlight leads to excessive heating, while sunlight can be the main source for getting daylight into the interior spaces. Hence, architects must not only design the buildings to collect energy from the sun to reduce heating and lighting costs, but also to reject solar energy when it leads to overheating of the building. The perforated layer can play this role. Dependently, some architects have designed perforated envelopes to consist of two or more perforated layers, to effectively -or highly- prevent the heat gain, as those cases are located in the arid and tropical climatic zones, and the used materials in those cases are diverse: concrete and stone, brick, and wood (i.e. KAPSARC Mosque, KSA).

(Roof perforation)

<table>
<tr><td rowspan="2">Q.7</td><td rowspan="2">What is the type of roof perforation?</td><td>Perforated dome</td><td>Flat</td><td>Inclined</td><td>Others</td><td>Not perforated</td></tr>
<tr><td></td><td>6 cases</td><td>3 cases</td><td></td><td>51 cases</td></tr>
</table>

Unlike the traditional models of roof perforation (perforated domes and vaults), the roof perforation in the contemporary trend is limited to very few cases, maybe due to the need for future vertical extension in buildings, and due to the little reliance on the sunlight for mainly lighting the deep internal spaces, due the availability of artificial lighting.

Few cases have flat and inclined perforated roofs, when no need for a future vertical extension in the building (i.e. museums), or when the roof perforation doesn't mainly influence the future vertical extension. In these few cases, the perforation helps to increase the daylight transmission to the interior, it works as a skylight. While, there is no evidence that the roof perforation has been used to play a role in controlling heat gain and heat loss, or in improving the natural ventilation, etc.

(Perforated material)

<table>
<tr><td rowspan="6">Q.8</td><td rowspan="6">What is the type of perforated material?</td><td>Wood</td><td>Concrete</td><td>Metal</td><td>Stone</td><td>Brick</td><td>Ceramic</td><td>Organic fibres</td><td>Terracotta</td></tr>
<tr><td>6 cases</td><td>9 cases</td><td>25 cases</td><td>2 cases</td><td>6 cases</td><td>2 cases</td><td>2 cases</td><td>1 case</td></tr>
<tr><td colspan="2">Reeds</td><td colspan="4">Thermoformed plastic + TiO2</td><td colspan="2">Metal + Polyethylene</td></tr>
<tr><td colspan="2">1 case</td><td colspan="4">1 case</td><td colspan="2">1 case</td></tr>
<tr><td colspan="2">Steel + Ceramic</td><td colspan="2">Brick + Glass</td><td colspan="2">Glass + Cement</td><td colspan="2">Stone + concrete</td></tr>
<tr><td colspan="2">1 case</td><td colspan="2">1 case</td><td colspan="2">1 case</td><td colspan="2">1 case</td></tr>
</table>

The perforated material is clearly an architectural basis, where the construction material's selection is not only about choosing the strongest, cheapest, or the most available materials, but also architects choose the warm, formal, and functional materials. Material selection is a complex process that has been determined by numerous preconditions, decisions, and considerations. The current material selection tools, however, focus mainly on the technical aspects of materials.

In order to make well-considered and justifiable material choices, architects need information about all of the material's properties to be considered during the design and selection process. Therefore, the survey of the used perforated material's in the sixty cases indicate that the perforated metals (i.e. aluminum sheets, steel sheets, iron, etc.) were used widely (25 cases) in different climates (moderate and arid climates). This seems technically a reasonable change, due to the advantages of the lightweight materials in the implementation process and the easiness of their formation. But, are metals economically and environmentally efficient in the different climates?

Surely they are not always efficient, due to their high thermal conductivity which doesn't fit the hot climatic regions. Therefore, it is not possible to use metals in all climatic zones without significant treatments. In this case, an appropriateness of perforated building's materials should take place in the design process.

The high use of perforated metals coincides with the great decline in the use of conventional building materials such as stone (which is definitely considered as the most noble and satisfactory material), wood (including plywood, hardwood, and ironwood), earth and reeds, bricks as a makeshift material, terracotta, and ceramic, etc.

Composites and mixtures of materials start to take a place in the contemporary trend, such as the use of stone and concrete together, glass and cement together, steel grids filled with ceramic sleeves, perforated bricks filled with glass bottles, and metals and polyethylene together. Furthermore, an innovative material has been used as a smog-eating material, which is the thermoformed plastic mixed with titanium dioxide (i.e. Torre de Especialidades Hospital, Mexico).

(Creation method of perforation)

Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels
		20 cases	**40 cases**

In all of the selected cases, there are two methods to create a perforated envelope; firstly, by the use of prefabricated drilled panels/units or by casting them on-site using specific moulds; secondly, by arranging and interlocking the units/blocks on-site in a certain order to produce the perforation during the construction process, by leaving spaces between the units/blocks (Fig. 4.1).

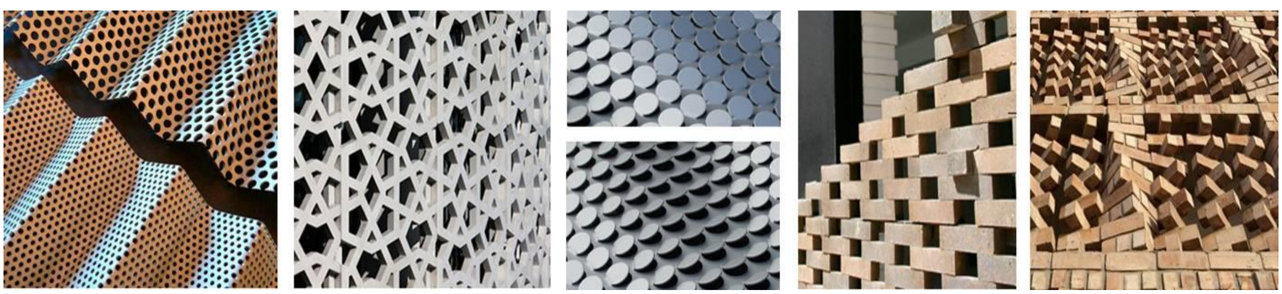

Figure 4.1: Methods of creating different perforations by using different patterns and different materials (references from left to right:<https://it.pinterest.com/pin/408701734905337737/>,<https://www.architonic.com/en/product/ivanka-perforated-panels/1320310>, <http://tuschalleng.com/perforated.html>,<http://www.akdn.org/architecture/project/40-knots-house>, <https://es.pinterest.com/pin/92746073554973475/>, all accessed on (02/2016)).

These two methods have their influences on the construction costs, while the most used method is the first one, as the most used materials are metals, where they are usually pre-perforated in a form of panels with certain dimensions (prototype). The pre-perforation of panels might be the easier way, but also it is not the cheapest way.

(Material behind/in front of the perforated layer)

Q.10	What is the type of material behind the perforated layer?	Wood + glass	Concrete + glass	Metal + glass	Terracotta + glass	Glass	NA
		1 case	**11 cases**	**1 case**	**1 case**	**29 cases**	**17 cases**

In the double-skin perforated envelopes, the perforated layer has been followed by another construction layer (the inner/outer skin layer) which has been constructed using different materials in different cases (43 cases). The other 17 cases have just single-layer in their envelopes.

In 29 cases, the glass was used as an internal skin layer behind the perforated layer (excluding the vertical and horizontal structural elements), where the glass layer was mostly used in the temperate climatic zones, especially when the perforated layer is made from metals. Despite this, there are some cases in the arid climatic zones having a thin metallic perforated layer with an internal glass layer, which, if it is not treated well by using specific design techniques or by using insulations within the external layer, causes some thermal problems due to the high thermal conductivity of metals. This problem is not limited to the arid zone, it can be significant also in some temperate regions such as the Mediterranean region which has relatively hot summer and cold winter.

In 14 cases, the layer behind perforation was partially divided into two materials: the glass as a material for windows and openings; and another material such as wood, concrete, metals, and terracotta for the solid zones of the internal layer.

(Perforation pattern shape)

Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Organic
		48 cases	**1 case**	**6 cases**	**4 cases**	**1 case**

The results show that the primitive geometries have been used to give a shape for perforated envelopes overwhelmingly (53 cases), by making certain orders and arrays of squares, rectangles, triangles, polygons, circles, ellipses, and rhombus, etc. Where perhaps it has lower cost and the easier to create a perforation shape into different materials of different properties (hardness and tightness, rigidity, stability, etc.) in both cases of drilling the panels or by interlocking the blocks.

Other perforation shapes were used in some other cases, such as floral shapes, irregular shapes, or shapes with symbolic significance. These complex shapes need special moulds to be casted or manufactured, which may make the technical process harder and more expensive, while their use could be inevitable when they give an architectural identity to the building, as the primitive geometries are neutral shapes with no great signs for a specific architectural identity, or signs to distinguish the building's geographical location.

(Perforation sizing)

		Very tiny-sized	Small-sized	Large-sized	Variant
Q.12	What is the perforation approximate sizing?	**31 cases**	**21 cases**	**3 cases**	**5 cases**

Further than giving an aesthetic or a symbolic value to the building's envelope, the perforation sizing affects the daylight transmittance and the amount of solar heat flow into the building's spaces. It also controls the levels of occupants' visual privacy, and their view-ability of the outside environment when the perforated envelope is not kinetic or dynamic, or when it has no movable or openable elements.

Perforation sizing indicates the approximate size of each single hole within the perforated envelope. The results show that the greatest used are the very tiny-sized perforations, where the hole's largest width/diameter is less than the human forehead scale (150mm). It is followed by the use of small-sized perforations where the hole's smallest width/diameter is within the human forehead scale (150mm) and up to the vertical scale of the human face (230mm).

These sizes (very tiny and small sizes) give the meaning to the perforation, otherwise it would be like openings or windows as used in some cases of large-sized perforations, where the hole's smallest width/diameter is more than the vertical scale of the human face (more than 230mm, Fig. 3.5). Dependently, the perforation sizing should not negatively affect the function of the building's envelope, as it is discussed in the following questions those have a direct link to this regard.

(Perforation's configuration)

		Regular arrays	Irregular arrays
Q.13	What is the configuration type of perforation?	**55 cases**	**5 cases**

The irregular distribution of perforations into the surface of a building's envelope may affect the distribution of daylight and heat transmission into the internal spaces, some spaces can get more daylight and heat than others. It also makes differences to the level of occupants viewability from a space to another.

The configuration of perforation was mainly regular in 55 cases, which means that the perforated panel has a regular distribution of the holes into its surface. Despite this, the issue of configuration is also related to the creation of partial or full perforations, which also produces an uneven distribution of perforations into the building's envelope, which in turns leads to uneven distribution of daylight, ventilation, view-ability, thermal transmittance, etc., as discussed in the subsequent points.

(Perforation ratio)

Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant
		2 cases	**26 cases**	**26 cases**	**2 cases**	**4 cases**

The perforation ratio was calculated for each case as clarified in the methodological approach part, where the results indicate that the dominant perforation ratio was approximately inserted in the groups of 10-35% and 35-50% in most cases, which seems near to the standards of openness ratio (35% according to Cruse, 2012).

Rather than the sunlight control, the perforation ratio was decided by designers due to some other reasons, such as the stability and rigidity of the perforated panel, the lightness of the perforated units to be easily installed into the building's envelope (i.e. Kalzip solutions, Fig. 4.2), in line with the easiness of controlling the dynamism (open/close) of the envelope, when applicable. While the perforation ratio remains linked to the openness ratio, in order to determine the amount of daylight transmittance into the building, as discussed in Q.21.

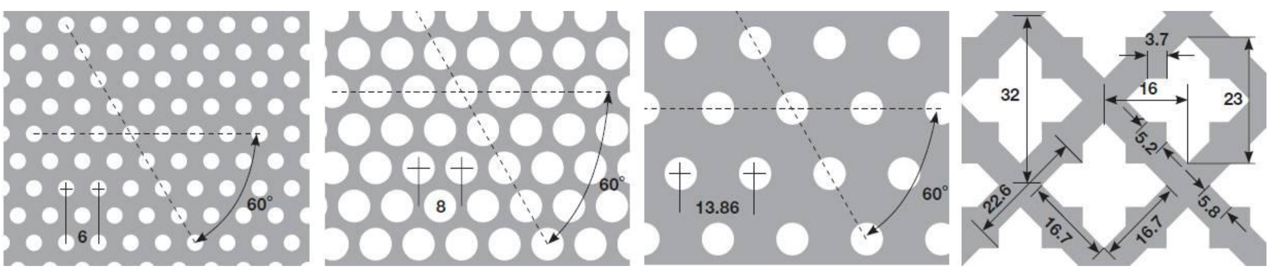

Figure 4.2: Different perforation solutions those are obtained by Kalzip, <http://www.kalzip.com/PDF/uk/perforated/Perforated%20solutions%20grid%20pattern%20overview.pdf>, (04, 2016).

(Perforated layer thickness)

Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant
		17 cases	**20 cases**	**19 cases**	**3 cases**	**1 case**

Continuously, the thickness of the envelope's perforated layer is an important aspect of the design process, due to the correlation between the thickness of material and its thermal conductivity and thermal capacity, and also the birds' ability to nest, beside others important correlations.

In regards to the thermal capacity, the very thin metal sheets -as an example- are lightweight, but they are ductile and thermal conductors. The high temperatures may affect materials in different ways, such as the dimensional change (i.e. thermal expansion), chemical change (i.e. decomposition, oxidation, ignition), physical changes (i.e. drying, segregation, out-gassing, color change, etc.), and other possible changes. Therefore, the larger thickness of a material plays a significant role in increasing its thermal efficiency and its thermal capacity, which helps in controlling heat transfer (i.e. earth, stone), while this is not always valid.

The results show that the perforated layer thickness in most cases was between 1mm and 30 cm, divided into three ranges, depending on the type of perforated material. The perforated materials of 1-9 mm thickness are almost metals. The question here: are there some kinds of thermal treatments for thin materials in the selected cases? the answer is gotten in Q.25, 26.

(Air cavity depth)

		<0.59m	0.6 - 1m	Over 1m	Variant	NA
Q.16	What is the approximate depth of air cavity?	**12 cases**	**7 cases**	**17 cases**	**1 case**	**23 cases**

Some designers have created an air cavity with a certain depth (double-skin), which separates and connects the perforated layer and the main envelope's layer (Fig. 4.3). The air cavity makes several environmental changes and enhancements to the envelope's function, it may negatively or positively affect the socio-cultural issues, if they are not well considered in the design process.

The air cavity cools and increases the air circulation between the two layers, and decreases the heat gain and changes the shaded zones. It was existent in 36 cases, where its depth is variable, sometimes narrow (for technical and environmental purposes), and sometimes wide (for technical, functional, and environmental reasons).

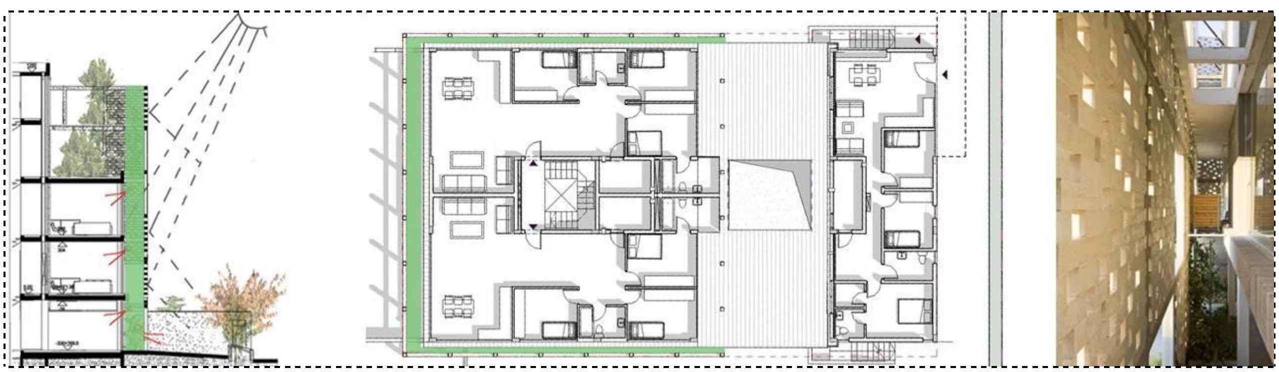

Figure 4.3: Wide and narrow, accessible and inaccessible air cavities (double-skin envelope) in the Mashrabiya house in Jerusalem-Palestine, <http://www.archdaily.com/175582/the-mashrabiya-house-senan-abdelqader>, (04,2016).

(Dynamism of perforation)

Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces
		13 cases	**47 cases**		

The dynamism of a building's envelope plays an important role in the energy saving and in enhancing the quality of the indoor environment (Fig. 4.4). Envelopes those have moveable or openable parts are more adaptive and interactive by actively responding to the prevailing climatic conditions, to enhance the energy performance and the occupants' comfort levels.

Components related to the dynamic building's envelope range from open-able or moveable windows and panels to the use of a kinetic envelope or a smart responsiveness of motion (i.e. Institute of the Arab world, Paris), etc. When a building's envelope is dynamic or has openable elements, then the environmental and social functions can be controlled upon the occupant's instantaneous needs, where they can close, open, or move windows or other dynamic elements as needed, whether it is based on the passive or active design techniques.

Figure 4.4: Different examples of dynamic/openable perforated envelopes, references from left to right: *<http://www.domusweb.it/en/news/2016/05/03/studio_admun_cloaked_in_bricks.html>, <https://it.pinterest.com/pin/442619469602168849/>, <http://www.dezeen.com/2010/05/25/cherokee-by-pugh-scarpa/>, <https://alastairgordonwalltowall.files.wordpress.com/2016/05/e4839d983ec329aa5299e38973aae77b.jpg>, all accessed on (05/2016).*

Nevertheless, the results show that the used perforated envelope's layers were mostly fixed/static (47 cases), where they are non-moveable and not open-able. This limits the ability to control or adjust the environmental quality inside the building and decreases the visual connectivity with the outside. The envelope's dynamism or open-ability is not significantly important in all public-use buildings, but it is important in the residential-use buildings. The 47 cases are distributed between both uses. Thus, it raises several inquiries to be highlighted in the subsequent sections.

(Supporting openings)

Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA
		14 cases	**10 cases**	**4 cases**		**32 cases**

Designing non-moveable perforated envelopes might not be a major obstacle if there are windows alongside with the perforated panels, in the case of a partial perforation. This issue has been taken into consideration while analyzing the cases, where the results show that 18 cases from 28 partially perforated cases have open-able parts or windows alongside with the perforation, where the other 32 cases are fully perforated and treated as mentioned in Q.17.

This issue carries a set of variables to the perforated envelope's design, such as changing thermal calculations and making possible changes to the idea of perforation. It makes -sometimes- the perforated panels as a complementary functional component if the windows existence is suitable (i.e. Ornans Infant School, 4 houses in KSA), or it makes the windows as complementary design elements if their existence is few (i.e. Lightmos Company).

4.2.2. Environmental outcomes

Climatically, the building's envelope should be designed to moderate the climatic effects by benefiting from the passive and active designs. For example, in the cold zones, the buildings should be ideally designed to reduce the exposed surface area to minimize the heat loss. In the temperate climatic zones, the heat loss in winter can be significant also, and heat gain in summer too. The hot-humid zones are the most difficult, as the building should be designed for maintaining the maximum amount of natural ventilation. Similarly, in the hot-arid zones, the shading from the direct sunlight is required.

Geographically, it is well-known that the site conditions affect the architectural design. Designing in a rural area differs from that in an urban area within the same country, as the user's needs and habits differ, and even the economic capacity. Therefore, the urban sprawl of a specific region may bring significant changes to the architectural form differently in the city borders, the suburbs, the rural areas, and old cities and city centers. This is rationally true due to the different developmental process, interests, and capabilities. In this regards, the contemporary trend of perforation was found in different geographical locations, but mostly inside cities due to the higher developmental process, and the priorities.

Topographically, the flat site may not influence the location and layout of the building. While on a sloping site, the topography is likely to be a significant design factor. The slope of a site may affect the access to sun and views. For example, an east-facing hillside will reduce afternoon and evening sunlight, particularly in winter depending on the height and steepness, a south-facing site may receive little or no sun during winter or during specific periods of winter. The selected cases are mostly located on flat topographical sites, which means no great impact on the design of the building itself. The impact of perforation's design and the orientation of the building façades would be more significant, depending on the percentage of voids and solidness into the envelope.

Dependently, the environmental analysis shows significant results in regards to the sixty analyzed cases, as follows:

(Designer intention)

<table>
<tr><td rowspan="4">Q.19</td><td rowspan="4">What is the designer's intention of creating the perforation?</td><td>Environmental</td><td>Aesthetic</td><td>Conceptual</td><td>Environmental + Aesthetic</td></tr>
<tr><td>6 cases</td><td>12 cases</td><td>3 cases</td><td>26 cases</td></tr>
<tr><td colspan="2">Environmental + Conceptual</td><td>Environmental + Socio-cultural + Aesthetic</td><td>Environmental + Socio-cultural + Conceptual</td></tr>
<tr><td colspan="2">5 cases</td><td>6 cases</td><td>2 cases</td></tr>
</table>

Exploring the designer's intention beyond creating the perforated envelopes, leads to the understanding of whether the main concept of perforation helps positively in maintaining a sustainable envelope's design, or it is just and aesthetic matter which might affect negatively the achievement of sustainable design. The results show a positive indication of considering both the environmental and aesthetic values together in the design of the perforated envelopes. While the most positive are the considerations of three or more of the environmental, socio-cultural, conceptual, and aesthetic values, where they are considered together in few cases. Despite all, there are 12 cases of considering only the aesthetic values and neglecting other values, which weaken the function and the concept of perforation, contrary to its integrative function among history.

(Orientation purpose)

<table>
<tr><td rowspan="2">Q.20</td><td rowspan="2">What is the purpose of orientating the perforated facades?</td><td>Environmental</td><td>Not considered</td><td>Inevitable</td><td>Conceptual</td><td>Others</td></tr>
<tr><td>19 cases</td><td>33 cases</td><td>8 cases</td><td></td><td></td></tr>
</table>

Following to what has been discussed in Q.4 and Q.19; if the orientation of the perforated facades is functional, then the perforation itself would be also functional. This was valid in only 19 cases, where the environmental orientation is considered, to take advantage of the sunlight, and at the same time to control the excessive amount of solar heat. Despite this, the contemporary perforation extended to include all the use categories of building, unheeding the functional capacity of the purpose behind the perforation design in many cases where the perforation used in different facades using -sometimes- similar technologies, similar perforation sizing, similar perforation ratios, and similar static/dynamic solutions, without considering the differences in the facades exposure to the sunlight, and the changing amount of daylight from direction to another.

This can be considered as a leap in this regard, where the perforated models in the traditional architecture were mostly functional following the building's use, with a focus on its use in the residential buildings. A minor excuse can be given for not highly considering the environmental orientation of the public buildings, while it is critical for the residential buildings, following the functional and environmental needs for occupants.

(Daylight transmittance)

		1-10%	11-35%	36-50%	Over 51%	Variant ratios
Q.21	What is the facades' daylight transmittance ration (openness)?	**3 cases**	**34 cases**	**17 cases**	**3 cases**	**3 cases**

The visible transmittance ratio (the daylight transmittance ratio) equals the perforation ratio in the case of fully-perforated and static facades. The transmission of daylight to the internal spaces is a considerable design aspect, whether the building is residential or public use. The daylight transmittance is the percentage of visible daylight striking the glazing and perforations that will pass through, where its values should fit the eyes relative sensitivity to different wavelengths of light, to provide sufficient daylight by avoiding the glare problems. The visible transmittance is changeable following the changes of weather, sunlight intensity during the day hours, and the used glazing system. Furthermore, the needed amount of daylight depends on the task inside the building's spaces.

Calculating the perforation ratio is not enough (Q.14) because the amount of transmitted daylight decreases when the internal layer of the double-skin facades has solid zones and increases by the existence of windows beside the perforation in the partially perforated and dynamic envelopes. The daylight transmission ratio was calculated similarly to the perforation ratio, but by considering the solid areas of the envelope's internal layer and by adding the windows areas in the partially perforated envelopes.

The percentage of daylight transmission has been mostly within the groups of 11-35% and 36-50%, which seems near to the standards of suitable openness ratio (35% according to Cruse, 2012), This proves that most designers have paid certain attention, intentionally or unintentionally, towards the amount of daylight needed for the internal spaces to be lit comfortably.

(Natural ventilation)

		Yes	Slightly	No
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	**26 cases**	**15 cases**	**19 cases**

Continuously, ventilation and natural air passage into the interior intersects with the previously discussed points, especially with Q.17. The way that the building users get the natural ventilation is different from case to case (manually, mechanically, etc.) while opening and closing the envelope's parts are always significant to naturally ventilate the building upon the need which alters following the weather changes and the occupants needs inside the building. Natural ventilation and passive cooling not only help to acquire the environmental needs, but also decrease the costs of using the active solutions to cool and ventilate the building's spaces (i.e. using the air-conditioning and fans).

The dynamism status of the perforated envelope is directly correlated to the natural ventilation, where the passive cooling serves better thermal comfort, acceptable indoor air quality, and also facilitate the daylight performance when opening the envelope's parts to get the direct sun during winter, and indirect sunlight during summer. Furthermore, closing the dynamic perforated envelope's parts blocks the unneeded direct sunlight in the summer daytime, and then opens for cooler air during the summer nights.

The issue of natural ventilation and passive cooling was considered in many cases, while 19 cases still have no considerable passive design techniques for cooling or ventilation. Even if most of these buildings are public-use, it does not preclude the idea of using the means of passive cooling systems due to their environmental and economic benefits.

(Perforated material's source)

		Conventional	Modified conventional	Man-made common	Man-made modified	Variant
Q.23	What is the perforated material's source category?	**14 cases**	**4 cases**	**36 cases**	**5 cases**	**1 case**

Envelope's perforated materials have been classified into several categories depending on the source of each material as shown above. In this regard, the results show some creative and innovative attempts to improve the used materials, by creating different mixtures of materials, or by the producing new innovative materials (i.e. thermoformed plastic + titanium dioxide) which increase the effectiveness and efficiency of the perforated building's envelope. There are also some other attempts to take advantage of the conventional materials with certain modifications to fit the contemporary needs and technologies, and also the climate. These results add positives to the trend. However, the huge use of man-made materials, especially the metals, remains critical as referred to in Q.8.

(Perforated material's thermal capacity)

		High	Moderate	Low	NA
Q.24	What is the level of perforated material's thermal capacity?	**31 cases**	**2 cases**	**27 cases**	

Building materials differ from region to region following their properties of resisting moisture, humidity, heat gain and heat loss, their hardness, porosity, flexibility, stability, ductility, etc., where some construction materials are more relatively resistant to heat transfer, moisture, rainwater, flooding, and fungi, more than other materials.

The building envelope has the first exposure to the climatic changes, therefore it has a great importance to be thermally well-designed. Selecting suitable materials is an important step in the design process, where the selection depends on the material's properties of thermal conductivity, expansion, reflectance and absorbance, appropriate thickness, etc. Accordingly, and taking these properties into consideration, the used materials in the sixty cases were classified in regards to their thermal capacity in different categories, as shown above. The results show that the great use was mainly divided between materials with relatively high thermal capacity and materials with low thermal capacity. The low capacity materials were mainly used in the cases of double-skin envelopes, which helps in decreasing the heat transfer between inside and outside due to the existence of the air cavity, while this is not the valid for all cases, or for all of the climatic zones.

(Insulations within the perforated layer)

		Yes	No	Not in all facades	NA
Q.25	Does the perforated layer have insulations?	**11 cases**	**49 cases**		

The building's envelope should be a thermal barrier or a shield that maintains thermal comfort for occupants by controlling heat gain and heat loss. Therefore, it has become axiomatic to know the positives of using insulations within the building's envelope, especially when the envelope's material has the low thermal capacity or it can't resist moisture and rainwater very well. Whereas, using insulations (thermally, acoustically, or as waterproofs) within the envelope's layer has a significant role in decreasing running costs of cooling and heating the internal spaces, without neglecting the passive design solutions.

Despite all, it is important to know whether the use of insulators has been considered in all cases or no. The results indicate little interest in using insulations within the perforated layer, especially when using thin perforated layers in the cases of double-skin envelopes, where the internal envelope's layer has sometimes insulations (this is evident in the subsequent point).

It some cases, the perforated layer has specific insulators, especially in the cases of single-skin envelopes envelope. Where the types of used insulations were different, sometimes they were just by creating hollow perforated blocks/panels (i.e. Teresianas-Ganduxer School), and sometimes the used metals were filled with ceramic or another material of high thermal capacity (i.e. Seville Ceramics Museum). Nevertheless, the use of insulation within the perforated layer is still dramatically non-dominant in the contemporary trend.

(Insulations behind / in front of perforation)

Q.26	Does the layer behind/front the perforation have insulations?	Yes	No	Not in all facades	NA
		21 case	**25 cases**		**14 cases**

Complementing to the previous point, the thermal insulation was considered in the design of the envelope's internal layer (in the cases of double-skin envelopes) only in 21 cases out of 46 cases, which is less than the half. As discussed previously, the air cavity between the two layers of the double-skin envelopes can reduce the heat transfer to some extent, but there are other problems might result from the use of perforated metals as external layer and the use of glass as internal layer, where the air cavity might not play a significant role to the required extent in this case, since it is necessary to use other design techniques instead of thermal insulation, or the use of thermal insulation in the perforated layer, for example.

(Shading ratio)

Q.27	What is the proportion of hole's size to the layer thickness?	1:1	2:1	1:2	5:1	10:1
		11 cases	**11 cases**	**5 cases**	**5 cases**	**3 cases**
		15:1	20:1	50:1	Variant	
		2 cases	**3 cases**	**2 cases**	**19 cases**	

The amount of solar radiation entering through the perforated envelope's holes doesn't only depend on the sizing of perforation and the perforation ratio, it also depends on the sunlight angles which can be changed by the proportions between perforated layer's thickness and the hole's size: if the perforated layer's thickness is equal to the hole's size, then sunlight enters through the perforations vertically only when its angle is less than 45 degrees; if the perforated layer's thickness is more than the hole's size, then less and less sunlight enters through the perforations depending on the dimensions of the holes' size and layer's thickness; while if the hole's size is larger than the perforated layer's thickness, then more sunlight will enter through the perforations, which increases the heat transfer and daylight transmission.

The analysis sheet considers the approximate proportions between the hole's size and the perforated layer's thickness. The most important parameter is not the approximate proportion value itself, but the proportion concept itself. The results show that the proportions were equal (1:1) in 11 cases, where the sunlight of angle more than 45 degrees will not pass through the perforations (Fig.4.5); the perforation sizing was approximately double the layer's thickness in 11 cases, where the sunlight of a vertical angle more than 63 degrees will not vertically pass through the perforations; the perforation sizing was half of the layer thickness in 5 cases only, where sunlight of a vertical angle more than 27 degrees will not vertically pass through the perforations.

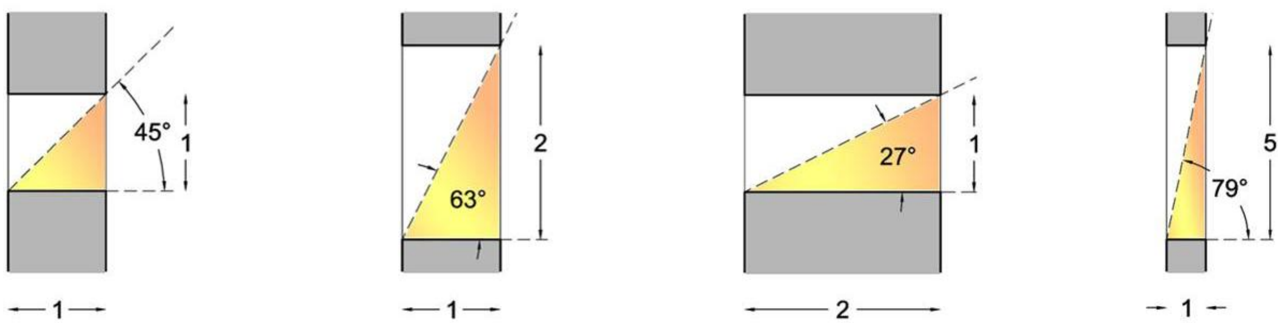

Figure 4.5: Different proportions of perforation sizing to the thickness of the perforated layer and the change in sunlight angles.

The sunlight remains horizontally (in the azimuth direction) passing through the holes in all cases, with different ratios depending on the building's orientation and the proportion between hole's size and the perforated layer's thickness. While when the proportion (size to thickness) is more than 5:1 (in more than 15 cases), then the sunlight will vertically and horizontally pass through the perforations even in the longest day of the year, when the sunlight altitude angle is closer to the right angle (Fig. 4.5).

(Moisture resistance)

		High	Moderate	Low	NA
Q.28	What is the level of material's resistance to moisture and rain?	**11 cases**	**49 cases**		

According to the Q.25 and Q.26, resisting the moisture and rainwater depends primarily on the envelope's external material, where some materials have higher resistance to the climatic conditions than others. Before thinking of the waterproof, the use of the moisture-resistant material is important so as not to be damaged in a short period of time; so as not be exposed to rust; to resist the rapid growth of fungi and discolouration; and so as not to lose its strength and coherence.

Hence the obtained classification of the used materials in the sixty cases depends on what was referred to in the research methodology. The results show the great use of high and moderate-resistant materials, with no use of low-resistant materials, due to the treatments of certain materials to increase their resistance, such as using painted or galvanized metals, zinc-coated metals, aluminum, or the use compressed bricks, treated concrete, hardwood and ironwood, etc.

All of the mentioned positives do not eliminate the time-effect (increasing and decreasing of temperatures, continuous exposure to the moisture and relative humidity) on the strength and durability of the material and its resistance, where there is a need for a periodic maintenance as clarified in Q.52.

(Decreasing heat transfer)

		Yes	No	Slightly	NA
Q.29	Does the perforated layer help in decreasing the heat transfer?	**38 cases**	**5 cases**	**17 cases**	

This is an accumulative point, as it depends on the previously discussed points, taking into account the dynamism and open-ability of the envelope's parts, the perforations sizing, the perforated layer thickness, the perforated material type, and the use of insulators.

The results show that, generally, the heat transfer is relatively decreased by the use of perforation by taking into account some of the before-mentioned aspects. Despite this, the reduced level of heat transfer in all cases might be relatively not enough as required in each case. Accordingly, this matter needs some simulations and calculations to be exactly judged.

(Passive design techniques)

		Yes	No
Q.30	Are there other used passive design techniques/elements?	**14 cases**	**46 cases**

Respecting the environment and using the passive design techniques are important in the building sector, where they can be strengthened by increasing the vegetation, by using living walls; by using locally available materials, by the harmonies of colours and textures, by following the site topography and the suitable orientation, and by using some traditional or contemporary passive solutions, such as the use of courtyards, wind catchers, ventilated facades, Mashrabiyya, sunshades, etc. Those aspects were considered in the judgment: if the perforated envelope's design considers some of them to play an integrative functional role for maintaining environmental values or no.

In this regard, the few use of some supporting passive techniques besides perforation (14 cases) was mainly focused on the use of sunshades; planted walls; solar chimneys, wind catcher, courtyards and courtyards plantings, vegetation; movable tiles (case 57), vertically or horizontally oriented holes (case 59), or the use of other passive design techniques (cases 39,43). While in 46 cases, the dependency in the passive design techniques was mainly the perforation itself; the metaphor of Mashrabiya; or the use of double-skin envelopes.

(Envelope's dynamism method)

		Manual	Electro-mechanical	Smart	Others	NA
Q.31	What is the way of opening/moving the perforated envelope's elements?	**10 cases**	**3 cases**	**2 cases**		**45 cases**

An important issue in the environmental analysis is the move-ability of the perforated layer, to fit the changeable needs due to the seasonal climatic changes or the daily weather changes. The dynamic envelope, as discussed before, can be manually moveable/open-able, electro-mechanically kinetic, smartly kinetic, etc. Apart from windows, the perforated panels in the fully or partially perforated cases were often manually moveable, and few cases were smartly or electromechanically movable. Despite the growing global interest in the kinetic envelopes technology to improve energy performance, the static perforated envelopes were used in 45 cases. This issue has significant negative influences on the occupants' visual comfort, thermal comfort, and visible transmittance if it doesn't have other negative influences.

(Energy norms)

		Renewable energy	Non-renewable energy	NA
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	**1 case**	**4 cases**	**55 cases**

Depending on the previous point, only one case of the five cases of smart and electro-mechanical dynamism was based on the use of renewable energy to control the motion of the envelope's elements. This doesn't mean that the other 55 buildings don't use renewable energies, of course, some of them have renewable energy production technologies, and some cases have plans of reducing CO_2 to save the environment by using clean energies, environmental-friendly materials, healthy techniques, and technologies.

(Energy saving)

		Yes	Slightly	No	NA
Q.33	Does the envelope's design enhance the energy-saving?	**37 cases**	**19 cases**	**4 cases**	

Based on all of the previous points, the energy saving is not limited to the use of renewable energy, but it is well-known that the envelope's design itself can highly contribute to energy saving, which reduces the running costs of heating and cooling the interior spaces, and subsequently contributes to the reduction of CO2 emission and the negative effects on the environment. Accordingly, and following Q.29, fifty-six cases can be considered as their perforated envelopes contribute –in different extents- to the energy saving due to the thermal benefits of the perforation itself.

(Manufacturing and construction technologies of perforation)

		Yes: prefabricated panels	No: manually created	Others
Q.34	Does the perforation need technology for manufacturing?	**48 cases**	**12 cases**	

According to Q.9, the perforation can be created by using one of the two methods; by the interlocking of blocks; or by drilling the panels. Where those two methods require different technologies; the first method can be made on-site by using simple techniques while drilling the envelope's panels and pre-construction of the prefabricated perforated units need independent technology (Fig. 4.6). Dependently, answering this question is a reference for answering Q.49.

The results show that in 22 cases, there is a need for independent construction technologies or techniques to produce the perforated panels or the perforated envelope itself. This in turns increases the initial construction costs of the perforated envelopes, contrary to what has been followed in the other cases of using simple technologies to produce the perforated panels or envelopes.

Figure 4.6: Different prefabricated perforated panels with different needed technologies, references from left to right: <https://it.pinterest.com/pin/450922981416531061/>,<http://www.archiexpo.com/prod/lafarge/product-70029-968114.html>, <https://it.pinterest.com/pin/318489004879173691/>,<https://it.pinterest.com/pin/133630313914344853/>, all accessed on (04/2016).

(Awards and certificates)

Q.35	Does the building have some awards/certificates?	Yes	No	NA
		10 cases	**50 cases**	

The results show that 10 cases have been recorded as awarding projects (i.e. Agha Khan awards), or they have received global evaluation certificates (i.e. LEED certification, and HQE certification), indicating the roles of design technologies in improving the building's quality and efficiency, where the perforation is considered as one of these technologies. This proves, and in turns supports, the contribution of perforation technology in improving the environmental performance of buildings, which gives future potentials for the trend.

(Active design techniques)

Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA
		4 cases	**56 cases**	

There are multiple active design techniques, other than those already discussed ones, those can contribute to increasing the efficiency of the building's envelope and the efficiency of the building itself, in spite of their cost and their dependence on energy. These methods include the use of smart technologies, nanotechnology, smart glazing systems (thermo-chromic, electro-chromic, photo-chromic, etc), remote sensation, and many other techniques.

Excepting what has been mentioned in the previous points, some active design techniques were used only in four cases, those fall under the plans of reducing the carbon dioxide emissions rates; the use of photovoltaic sensors to control the envelope's dynamism (i.e. Institute of the Arab World); and other technologies (i.e. case no. 44). The few use of active design techniques in the selected cases has several indications, including the greatest focus on the passive design techniques, or the low focus on environmental solutions in the design of the envelope, it varies from case to case as discussed in Q.19.

4.2.3. Socio-cultural outcomes

Subsequent to the results of the environmental and technological considerations in the perforated envelope's design, it is worth to discuss the socio-cultural dimension, which is represented in the relationships between users and the building's envelope as a transitional point between private and public spaces; a connecting point between inside and outside; a convergence or divergence point between man and his environment; and a mirror that reflects the building cultural identity, its function, and its history. Hence, the analysis included the conduction of physical inquiries those resulted from the perforated envelope's design, and how they can influence the occupant's comfort inside the building.

Due to the complexity and the great discrepancy of occupants' behavior and their interaction with the building's envelope, the analysis sheet included just the tangible and reachable indicators those can be beneficial to be considered in the design phases (pre-occupancy phase). The socio-cultural indicators have three main components: the usability of the building envelope; user's adaptability with envelope design; and users and envelope connectivity to the local context.

The building's envelope design, technology, height, and overall shape, affect the way the occupants use it, the sunlight transmission into the building's spaces, occupant's privacy and view-ability of outside, the quality of internal spaces, the amenity and usability of semi-private spaces (such as balconies), and the interaction with the community. The easiness of using the envelope promotes the users' psychological and thermal comforts, as well as it promotes the social and environmental interactions between man and environment.

The socio-cultural analysis shows significant results in regards to the sixty analyzed cases, as follows:

(Cultural symbolism)

		Yes	No	NA
Q.37	Does the perforation pattern indicate a cultural symbolism?	**12 case**	**48 cases**	

In addition to enhancing the passive design strategies; successful massing and suitable orientation; and the design's contribution to the health and vitality of the surrounding ecological community, it is also important to enhance the social, cultural, and economic values within the envelope's design and the building's design itself. The building's envelope must connect the inside social spaces with the street life, directly or indirectly, and must connect occupants with the nearby natural scenery.

In regards to the perforation's pattern geometry and its cultural appearance in relation to the local context, the results show that the perforation patterns have certain cultural indications in only 12 cases (i.e. Kapsarc Mosque). Accordingly, the perforated envelopes follow the local cultural identities in limited extents, as they were generally designed to meet aesthetic and environmental values (i.e. Lille Metropole Modern Art Museum).

Several designers have chosen to create neutral pattern's arrays those were derived from primitive geometries such as circles, squares, rectangles, polygons, etc., which makes the trend with an international appearance, apart from using specific regional identities, or specific relations with local contexts.

(Material and community)

Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all materials	NA
		31 cases	**29 cases**		

In addition to the importance of selecting the construction materials in regards to their properties to meet the environmental needs, the choice also should consider the commonly used materials in the local community (especially the conventional materials) those have a role to link the building culturally with its surroundings to maintain an extent of the architectural identity, as well as the impact of material's availability on its initial costs (Q.53).

Despite all, it does not mean that the uncommon materials are always expensive, and have no cultural attachment and indication to the identity, but some innovative materials can be derived from the conventional or the new materials to achieve environmental objectives as well as considering the economic and cultural aspects of the building.

Benefiting from innovative technologies in manufacturing and implementation of the building's envelope can produce financially feasible materials; environmental-friendly materials; and technically sound materials. Hence, the results show that approximately 50% of the cases have no commonly used materials into their perforated envelopes. the use of modified or innovative materials was few, besides the great use of different new material, but not all of them are used mostly by the surrounding community.

(Accessibility of air cavity)

Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA
		17 case	**18 cases**	**1 case**	**24 cases**

The user's physical relation to the perforated envelope is significant, where the determination of the users reach-ability to the perforated layer is important to decide if the occupants are able to control the envelope upon their desires or no. When occupants can't reach the perforated layer in the cases of double-skin envelopes, it may influence their ability to manually open/close the external perforated layer of the envelope. Thus, the absence of open-able windows or the inability of users to control the open-able windows for any reason leads to the reduction of their thermal comfort's levels, as well as the negative impact on the social, psychological and visual comforts.

The air cavity existence adds environmental advantages to the envelope's function, often in cooling of air that mitigates between the two layers, which helps in decreasing the heat transfer in summer. But also, the cavity can add social and cultural benefits, where it is - in some cases - an extension to the internal spaces (a corridor or a balcony, Fig. 4.7) which balances or to separates between inside and outside environments, where this space can be called as a *transitional space*.

Figure 4.7: Examples of accessible air cavity in different cases of perforated envelopes (Germanà et. al., 2015).

The accessibility of this transitional space has been a focal point in the analysis sheet, to explore when it is accessible for technical purposes only, and when it is accessible for functional purposes. As shown in the results, about 50% of cases have just technical air cavities without being accessible by occupants, due to the inexistence of physical connection between this space and the internal spaces, or due to that the cavity depth doesn't fit the human scale (less than 0.60 cm).

(Perforation sizing and view-ability)

		Yes	Slightly	Not in all facades	No	NA
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there are no openable elements?	**51 cases**	**7 cases**		**2 cases**	

Pulling up / down the envelope's elements, and moving between spaces (inside and outside) are key issues for the building's design optimization; energy diagnosis; performance evaluation; and building's energy simulation, due to their significant impact on the energy use and indoor environmental quality. However, the influence of occupants' behavior is under-recognized or over-simplified in the envelope's design; envelope's construction; envelope's operation; and refurbishments of the building's envelope.

Occupants' behavior is complex, stochastic and multi-disciplinary, while understanding the occupants' behavior deeply and modeling and quantifying its impact on the use of building's technologies and energy performance of buildings, is crucial to the design and operation process of low-energy buildings.

In regards to Q. 12, Q.13, and Q.14, perforation sizing doesn't only change the occupant's thermal comfort levels, but also affects their direct or indirect relationships with outside, if there are no openable elements within the perforated envelope, which in turns, affects negatively the occupants' view-ability of the outside scenery depending on the perforations sizes.

Dependently, the very tiny-sized and small-sized perforations (31 cases, 21 cases as shown in Q.12) may produce blocked views, or difficulty view-ability of the outside environment (51 cases), where the perforation sizes are within or less than the scale of human face, (Fig. 4.8), as the man needs more closeness to the wall and even a certain focus to view the outside. Indeed, this situation constitutes -physically and psychologically- a barrier between occupants and outside the building, which consolidates the isolation of man from his environment, when the dynamism of the perforated envelope is not taken into account.

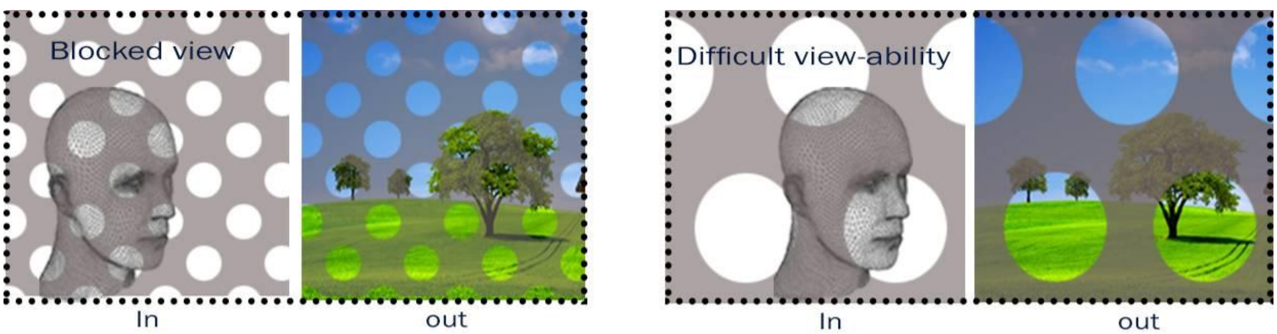

Figure 4.8: Viewability in the cases of very tiny-sized (left) and small-sized perforations (right).

(Air cavity and view-ability)

		Yes	Slightly	Not in all facades	No	NA
Q.41	In the case of double-skin, does the air cavity impede or obscure occupants' view-ability to the outside?	**20 cases**	**4 cases**		**11 cases**	**25 cases**

Based on Q. 39 and Q.40, the perforation sizing is just one factor in determining the occupants' view-ability to outside. Therefore, the user's ability to contact the outside environment plays an enormous role in strengthening the relation between users and the local community.

The second factor is the air cavity, which may impede or obscure the occupants' view-ability to outside if it is inaccessible, as it constitutes a distance between the occupants and the envelope's external layer, especially when the external layer is static and has not open-able elements. The results show that the air cavity can impede or obscure the occupants' view-ability in 20 cases, which consequently affects the visual comfort.

(Perforation configuration and view-ability)

		Yes	Slightly	Not in all facades	No
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	**51 cases**	**4 cases**		**5 cases**

The third factor that may influence the occupants' viewability is the distribution of perforations on the perforated surfaces (Fig. 4.9). When the perforated facade or the perforated panel has an imbalance in the perforation's configuration, then some interior spaces will get less visual connectivity with the outside more than other spaces in the same facade, which in turns, affects the natural ventilation and the amount of daylight transmittance to the interior spaces. This keeps invalid if the perforated facade or panel is openable, or if they have some windows alongside with perforations in the same facade.

The results show that most of the selected cases have some problems of the view-ability in some of the internal spaces due to the uneven configuration of perforations or the perforated zones. Some buildings have alternative design elements such as the internal courtyards and sky lighting, and some buildings have no alternatives except some few perforations, while this issue is functionally significant.

Figure 4.9:Changing perforation's configuration in different cases, references from left to right: <http://www.archdaily.com/789533/lt-house-tropical-space>,<http://www.contemporist.com/2015/03/02/a-facade-of-colorful-ceramic-blocks-cover-this-apartment-building/>, <http://amicoglobal.com/fabricated-products/applications/facades-sunscreens/>, *all accessed on (05/2016).*

(Perforation configuration and visual privacy)

		Yes	Slightly	Not in all facades	No
Q.43	Does the perforation's configuration increase visual privacy?	**57 cases**	**2 cases**		**1 case**

The occupants feeling of closure is a part of maintaining their privacy, which depends on the levels of visual transparency in the building's envelopes, as the fully transparent envelope doesn't provide privacy to that same level of what a fully solid envelope provides (apart from the environmental advantages and disadvantages). Dependently, the perforation's configuration, as well as the perforation sizing, influence the levels of occupants' visual privacy inside the building. The level of visual privacy depends on the transparency of the envelope; the building's closeness to the streets or the adjacent buildings; the site barriers; and even the local culture.

Feeling of closure and privacy has two sides: the negative side which resulted from the high percentage of envelope's solidness, which blocks the outside views, as well as disconnects the social relationships with surrounding community (i.e. Community Centre, Sedan-France), and consequently leads to the feeling of psychological discomfort. The positive side results from the high feeling of privacy in a perforated building with tiny-sized or small- sized perforation, due to the existence of openable or movable elements in the envelope upon the occupants need (i.e. Trollbeads Jewelry Building).

Determining the positives or negatives of closure is linked to reality rather than theory, depending on the users' satisfaction. Despite this, the results show that the perforation's configuration can increase the occupants' privacy, to different extents, in almost all of the cases (57 cases).

(Perforation and acoustical comfort)

		Yes	Slightly	Not in all facades	No
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	**41 cases**	**18 cases**		**1 case**

There are many factors that change the value of acoustical insulation and acoustical comfort in a building, regarding the sound absorption, reflectance, and attenuation. Those factors depend on the surface material's absorbance and reflectance coefficients, where they depend on the smoothness and porosity of the material itself. It is clearly known, for example, that the sponge absorbs the sound and the glass reflects it, due to the softness of the glass surface and the porosity of the sponge. This has become an axiomatic matter regarding the sound theories in physics (Lamancusa, 1990), where the pores become as protuberances that the sound fades away inside them after a series of reflections of the sound waves.

Hence, the question is: what is the relation between the perforation and this issue? The relation can emerge in the case of using small-sized or very tiny-sized perforations, of course they will not do as the pores do exactly, but the perforations can contribute in reducing the sound waves length after a series of refractions, reflections, and absorbance, when the perforated layer's thickness is large and the perforated material's type enhances this issue. But, it has been considered that some passing waves to the air cavity (in the double-skin cases) may produce echo inside the cavity, especially if the material behind the perforated layer is a reflector and non-absorbent.

According to this, the cases were analyzed, theoretically, based on the perforation ratio; and taking into consideration the proportions between the perforated layer's thickness and the holes' size; the perforated material type; the air cavity depth; and type of material behind the perforated layer, to decide if these factors indicate in an acoustical comfort, or noise reduction, to some extent, depending on Q.5, Q.8, Q.10, and Q.12. The results show that the perforation can play a role, in different extents, to reduce the noise effects, which in turns, plays a role in enhancing the acoustical comfort alongside with acoustical insulations.

(Air cavity and verbal contact level)

		Yes	Slightly	Not in all facades	No	NA
Q.45	In the case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	**25 cases**	**3 cases**		**10 cases**	**22 cases**

The dynamism of a perforated envelope and the design of accessible air cavities are only the factors of occupants' view-ability and connectivity to the outside environment (visual comfort), but also they are factors influencing the verbal contact level between occupants and community, especially in the residential buildings and complexes. In addition to this, the verbal contact level depends on how much the building is close to the adjacent street and to the plot's borders (Fig. 4.10), and also depends on the building's height. While it doesn't highly depend on the perforation ratio, sizing, and configuration, except in the case of static envelopes, as the larger sizing can enhance visual contact and maybe the verbal contact too.

In 25 cases out of 38 cases, the air cavity doesn't impede or obscure the occupants' verbal contact with outside persons. This seems acceptable as theses 25 cases are mostly residential buildings, which in turns, enhances the socio-cultural connectivity between the building's occupants and the local context, as the verbal contact between occupants and the nearby community can strengthen the social ties between people, as it has been in the traditional architecture (i.e. Mashrabiya model).

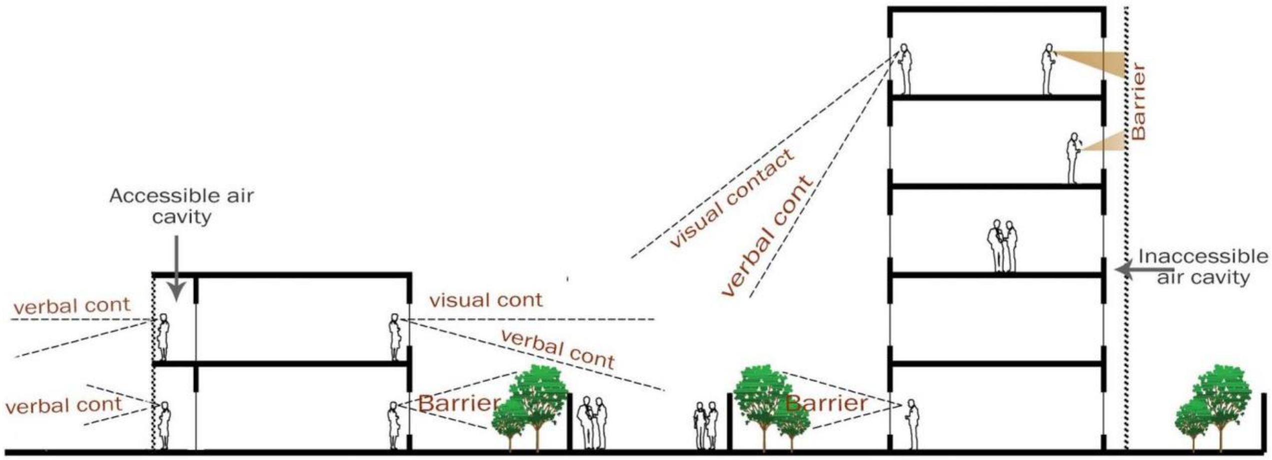

Figure 4.10: Accessible and inaccessible air cavity, visual and verbal contacts.

(Perforation and physical security)

		Yes	Slightly	Not in all facades	No
Q.46	Does the perforation increase the physical security?	**54 cases**	**4 cases**		**2 cases**

It has been evident that adaptation with the climatic change presents one of the most pressing challenges in the building sector. Adaptation relies on to the building's physical components in terms of their responsiveness to climatic changes, and occupants' behavior as significant influential factors.

Users adaptation with the envelope's design is influenced by how they maintain their physical and psychological security; privacy; visual comfort; acoustical comfort; thermal comfort; etc. If all of these factors are not properly taken into account in the design process, then the occupants' adaptation with that design will be critical.

Accordingly, the envelopes of almost all of the selected cases (54 cases) can be considered as physically secure, or at least the perforation helps in increasing the level of physical security, due to the use of protective perforated layers, where the designer cares about creating rigid, stable, and wind resistant perforated layer, which increases security factor within the building's envelope. The mutual relationship between physical and psychological security, in turns, leads to the feeling of security on the psychological level, which depends on the occupants' sense of material's strength; stability; and rigidity. The building height and the ratio of voids areas are also influential factors.

(Perforation and visual privacy)

		Yes	Slightly	Not in all facades	No
Q.47	Does the perforation increase the occupants' visual privacy?	**56 cases**	**3 cases**		**1 case**

This point is an accumulative and complementary to Q.43, where it depends on the other questions about perforation ratio; sizing; configuration; the number of envelope's layers; etc. The visual privacy is mainly related to the user's visibility and the envelope's transparency. The acoustical privacy is related to the external material's type; its texture; insulation material; and the site conditions. From this point, the acoustical privacy exploration is based on the existence of the acoustical insulation, and the external material absorbance or reflectance to the sounds, which is discussed in Q.45. This means that there is no reverse or mutual relationships between the visual and acoustical privacy, they are independent. For example, as mentioned before, when a building façade is fully solid, the visual privacy level will be high, while it doesn't mean that the acoustical privacy is high or low. Designing a fully or partially transparent envelope of a building in a conservative community, produces a deprivation in an essential need, the visual privacy, as the conservative occupants can't adapt without maintaining it, they will feel uncomfortable inside the building.

The results indicate that maintaining the visual privacy increases by using the perforated envelopes (in 56 cases) since the very tiny-sized and small sized perforations reduce the occupant's visibility. Dependently, the large-sized perforations; the use of partially perforated facades; and using transparent zones in the building's envelope may reduce the visual privacy. Despite all, the needed level of visual privacy depends on the building's use and the local culture, where it is more important in the residential buildings and for the conservative communities.

4.2.4. Economic outcomes

The building's envelope can be considered as the largest building's element in terms of size. It includes a substantial amount of materials, which significantly influences the building's sustainability, considering the costs associated with the embodied energy of the materials.

Any sustainable design of a building's envelope has to reduce the resources consumption and the environmental deterioration. The building's envelope -being one of the most important parameters of the passive design systems- influences significantly the resources consumption and environmental deterioration, besides affecting the whole initial and running costs of the building.

The economic impact of a building's envelope includes the initial costs (construction costs); the operational costs; and the envelope's maintenance, which can be very substantial. This study doesn't take into consideration the exact calculations to estimate these costs, but they were discussed regarding some indicators and factors those make sense of the economic feasibility of the building's envelope, where these indicators depend on the previously discussed technological, environmental, and socio-cultural factors.

Answering the economic questions show certain results in regards to the sixty analyzed cases, as follows:

(Perforated material costs)

		High	Moderate	Low	NA
Q.48	What are the perforated material's relative initial costs?	**25 cases**	**15 cases**	**20 cases**	

The envelope's construction costs are variable depending on the size of the building and its use category, but it is striking that some of the selected cases have assigned millions of dollars for each case. This could be a matter of debate regarding the building's economic feasibility if those buildings would be considered as good experiences to be disseminated on a wider range in the world.

Nevertheless, the economic feasibility of each case was analyzed by considering some key indicators to estimate the construction costs easily, including the envelope's construction and operation technologies, and the envelope's material type.

The results show that the costs of the used perforated materials are relatively high (25 cases), due to the needed technology for manufacturing the perforated panels; due the implementation process; due to the use of modified materials those uncommon in the local market; or due to the use of relatively expensive materials (i.e. thermoformed plastic + TiO_2). Despite all, a significant number of cases have relatively low-cost perforated materials, due to the use of common and highly available materials (i.e. earth, stone, concrete, reeds, etc.). This issue plays a considerable role in increasing or decreasing the construction costs of the building's envelope.

(Perforation technique costs)

		Yes	No	NA
Q.49	Does the perforation technique have independent costs?	**48 cases**	**12 cases**	

The perforation technology and perforation techniques can decrease or increase the envelope's construction costs. The costs of perforation techniques are not estimated in this research, while the analysis considers if the perforation technique needs independent costs (prefabrication and using special molds or drillings) or no, taking into consideration the detailed sections of the envelope, and its implementation process (as clarified in Q.34 and Fig. 4.6). The results show that, predominantly, the perforation technique needs independent techniques (i.e. Museum of Archaeology in Seró, and L'Atoll Angers), which in turns, increases the perforated envelope's initial costs. Despite this, there are some cases those don't need independent technologies to create the perforation (i.e. School of Cambodia), which gives a potential to the trend.

(Dynamism running costs)

		Yes	No	NA
Q.50	Does the dynamism of the perforated layer have running cost?	**4 cases**	**11 cases**	**45 cases**

Controlling the envelope's dynamism process may increase the building's running costs if the dynamism relies on the use of electro-mechanical means and the non-renewable energy. Therefore, the methods of controlling the perforated envelope's parts vary from pulling up/down the perforated panels, opening/closing the openable elements, or moving the envelope itself when it is kinetic, etc.

The results show that the envelope's dynamism costs are not applicable in most cases, due to the dominance of manual means of control, or due to the nonexistence of moveable elements into the perforated layer (fixed/static envelopes). This indicates that the smart technologies and the means of electro-mechanical controls are still not largely used in the contemporary trend.

The use of smart techniques, smart glazing systems (thermo-chromic, electro-chromic, photo-chromic), and using self-energy production methods (renewable energy) within the envelope itself, are active design techniques, where they indicate to what extent that the perforated envelope's design relies on the passive design techniques to reduce the operational costs of the building.

(Perforation and running costs)

		Yes	Slightly	No	NA
Q.51	Do the perforations decrease the building's running costs?	**33 cases**	**24 cases**	**3 cases**	

The building's related running costs associated with the operation; maintenance; repair costs; etc., might rely on the use of renewable or non-renewable energy. The operating schedules and standards of maintenance vary from building to building, regarding its type, technology, age, etc. Despite this, the perforation plays a certain role in decreasing these cost whether the operation relies on a renewable or non-renewable energy system.

The envelope's role in decreasing the running costs depends on: a) its thermal efficiency regarding to the used materials, technologies, etc.; b) its contribution in increasing the daylight transmission to the interior, which reduces the use of artificial light in the daytime, c) the use of renewable energy production means, d) the operational costs of the envelope's dynamism, if applicable.

Depending on the environmental indicators discussion, it has become clear that the perforated envelope plays a significant role in decreasing thermal transfer, by using either passive or active techniques, even if the perforations were designed for aesthetic values, but its contribution will be in different extents. This can be precisely estimated in the post-occupancy phases.

Despite all, it is necessary to reconsider the cases in which the metals were used as perforated materials and were followed by glazed layers, where the thermal transfer will be higher, and in turns, higher the running costs for cooling and heating.

The openness ratio and perforation ratio have an evidence to the amount of daylight transmitted to the interior in each case. Dependently, the results show that the perforation often helps in decreasing the envelope's running costs for lighting the internal spaces.

(Durability of perforated material)

		Yes	Slightly	No	NA
Q.52	Is the perforated material considered as durable?	**27 cases**	**32 cases**	**1 case**	

Choosing the envelope's materials is not the matter of selecting only the available materials; low-cost materials; easy-constructive materials; and high thermal capacity materials. But it must also consider the possible changes that might occur to that material with the passage of time, in terms of expansion and contraction; rot and discoloration; rust and break; etc. And also paying attention towards the possibility of treatment and maintenance of the selected material, so as not to affect the integrated form and function of the building elements. Briefly, the maintenance costs must be reasonable and not expensive, as well as the building survives for a reasonable time before the need for maintenance again.

Dependently, the durability of the envelope's material depends on its resistance to moisture and rain in regards to the requirements of the prevailing building code. Durable materials are a significant line of the envelope's defense against deflection, permeability, and other expected changes. Some claddings, such as brick veneer, are inherently durable, while some other materials may require an additional exterior finish.

Lastly, the resistance of the envelope's components to the climatic changes is subjected to their stability and rigidity; their resistance to wind and heat transfer; their compatibility with the climatic conditions that could destroy them; and the material's resistance to discoloration, rot, or fragmentation with time. Accordingly, material's durability, strength, and cohesion, can be improved by the technology used in the manufacturing and installation of the perforated envelope.

Thus, the results show that the durability factors were almost considered in all cases dramatically. While it doesn't mean that everything related to the material's durability has been considered. This is clarified in Q.60, where there are some problems, in some cases, related to the quick change of the material color (within few years) and the change of some properties, due to the seasonal climatic changes (Fig. 4.12, 4.13).

(Availability of perforated material)

		Yes	Slightly	No	NA
Q.53	Is the perforated material locally available?	**57 cases**	**3 cases**		

The envelope's construction costs include an estimation of the material's relative initial costs, where these costs depend on the use of local resources of materials, following the availability of material in the local context, since its availability plays a certain role in reducing the initial costs, by reducing the transportation cost, labour cost, etc. For example, brick as a building's material is highly used in east Asia as it is available and very cheap there, which also responds to the climatic changes very well. Accordingly, the results show that the use of available materials was dominant in the selected cases, while the modifications in the materials' properties, in some cases, might rise the initial costs.

(Rainwater penetration)

		Yes	Slightly	No	NA
Q.54	Is the rainwater penetration considered in the envelope's design?	**52 cases**	**7 cases**	**1 case**	

The envelope's ability to dry itself is important, especially in the case of double-skin envelopes. The rainwater that drains immediately between the two layers should be dried as quickly as possible principally, through the diffusion and ventilation. The drying potential of a wall is affected by several factors including the evaporation rate from its surfaces; the vapor movement by diffusion or air leakage; drainage gravity and convection; and air circulation between layers and over surfaces. The key factor is preventing the wetting rate from exceeding the drying rate, where the problems may occur with the passage of time.

Choosing suitably perforated materials those resist rainwater or the relative humidity, as long time as possible without significant damage, is important, especially in the climatic zones where the rainfall or the relative humidity is high.

Consequently, the previous points discussed the properties of the used perforated materials in terms of resisting moisture and decreasing thermal transfer, whereas the metals (steel, aluminium, iron, etc.) are used as perforated materials in several cases, while their resistance to moisture and rainwater was improved by coating, by galvanizing, or by using waterproof applications. In some other cases, the manufacturer made some modifications to the raw material for these reasons. In addition to the existence of a technological system to drain the rainwater that penetrates into the perforated envelope's layers.

The results show that the rainwater penetration was considered in the design of almost all cases, by modifying the used materials, or using some related techniques such as the use of ventilated facades; or the use of changing angles of perforations (in the azimuth and altitude directions) to drain the rainwater quickly; or such as providing evaporative cooling system to prevent the breeding of insects and fungal growth.

(Dust accumulation)

		Yes	Slightly	No	NA
Q.55	Is the dust accumulation considered in the perforation design?	**38 cases**	**5 cases**	**17 cases**	

Answering this question depends on the answer of Q.15, which is related to the thickness of the perforated layer, as the greater thickness gives greater opportunity to the accumulation of dust on the horizontal surfaces inside the perforations. This influences the aesthetic appearance of the building's envelope over time and leads to the need for successive cleanings over a short time, which has been discussed in Q. 58.

Results show that the probability of dust accumulation on the perforated envelopes' surfaces has been mostly taken into account in the design of perforated layer thickness differently: the perforated layer in some cases was very thin, so it doesn't allow the accumulation; in some other cases of thick perforated layer, the inner surfaces of perforations were inclined, so it helps to continuously getting rid of dust; but in other cases, there is a high probability for dust accumulation due to the use of thick perforated layers without any technical treatments to prevent dust accumulation over their surfaces.

(Birds nesting)

		Yes	Slightly	No	NA
Q.56	Is the bird’s nesting considered in the perforation design?	**42 cases**	**5 cases**	**13 cases**	

The perforation analysis has an exploration of some other technical aspects, such as the possibility of birds’ nesting inside the perforations’ spaces (Fig. 4.11), which needs prevention techniques within the design itself. It has been found that 13 cases have no considerable design techniques to prevent the birds’ nesting into the envelope’s holes. Often, in 42 cases, the prevention of birds nesting was achieved, either intentional or unintentional, by using thin perforated layers; inclined hole’s surfaces; dynamic perforated layers; or by the use of very tiny holes those doesn’t fit the bird’s scale; etc.

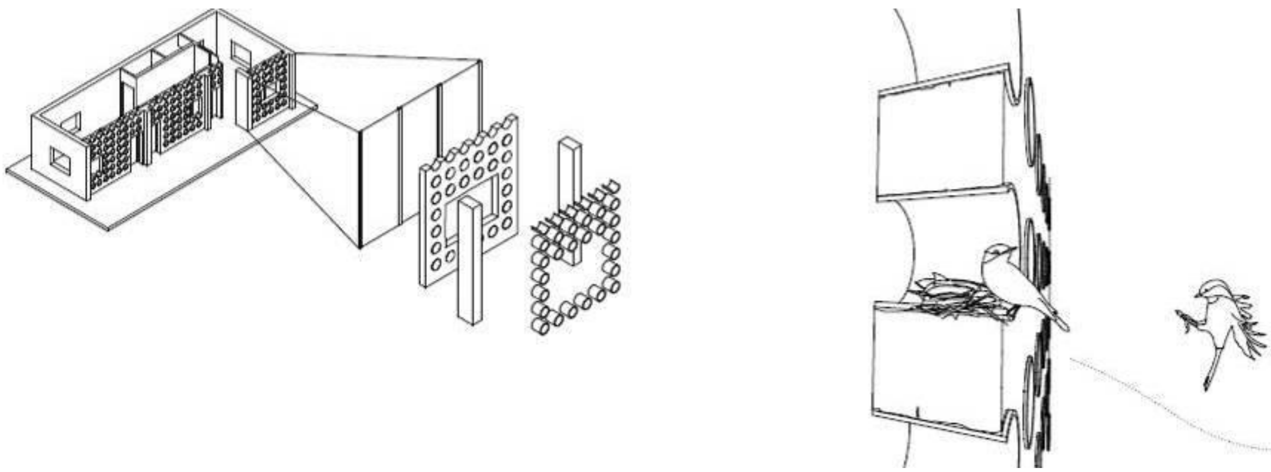

Figure 4.11: Illustrative drawings for birds roosting Vs perforated layer thickness (Decolonizing Architecture Group, Palestine).

Accordingly, the designer has to answer several questions about birds nesting: in what kinds of spaces the birds may nest? And how large is the preferred space for nesting? Answering these questions helps in deciding the technical solution to prevent the nesting problems in the design phases.

(Recyclability of perforated material)

		Yes	Slightly	No	NA
Q.57	Is the perforated material recyclable?	**28 cases**	**1 case**	**31 cases**	

The recyclability of the perforated material is quietly significant in decreasing the environmental problems related to getting rid of the demolished materials, nowadays and in the future, where the perforated materials can be easily recycled after their damage.

Metals, glass, and plastics are considered as recyclable building materials, where woods can be reused in different ways. Accordingly, the results show that approximately 50% of used perforated materials can be recycled, which eases the repair works and decreases the maintenance costs, as the material would not be a waste after a possible damage.

(Clean-ability of perforated layer)

		Yes	No
Q.58	Is the perforated layer easily cleanable?	**47 cases**	**13 cases**

In regards to Q.27 and Q.55, the clean-ability of the perforated layer depends on the perforations' sizing (the larger sizing, the easier cleaning), also it depends on the depth and accessibility of the air cavity in the case of double skin envelopes (the greater accessible depth, the easier cleaning). Furthermore, it depends on some other aspects such as the porosity of the used materials and their external face texture, etc.

Dust accumulation and spiders and insects gathering in the very tiny perforations need some treatments and design techniques in order facilitate the envelope's cleaning. In this regard, the results show that it is easy to clean the envelope's perforated layer in 47 cases (the need is only for basic cleaning equipment). While in 13 cases, it is relatively difficult to clean the envelope's perforated layer, where they need extra efforts and techniques (i.e. the use of an air pressure device). Those issues have to be taken into account in the design phases, to reduce the needs for maintenance.

(Clean-ability of the layer behind the perforation)

		Yes	No	NA
Q.59	Is the layer behind/in front of perforation easily cleanable?	**34 cases**	**8 cases**	**18 cases**

Successively, the clean-ability of the layer behind or in front of the perforated layer, in the double-skin envelopes, depends also on the depth of air cavity and its accessibility to make the needed cleanings of the layer's external surfaces. The layer's clean-ability is considered as easy in 34 cases out of 42 cases, while it is considered as relatively difficult in the other cases, due to the very narrow air cavity; the used material's type; its coarse textures; protrusions; pores; et.

The substantial aspect in the cases of difficult cleanings is the turn into impossibility, in some cases, where the cleaning agent has no ability to access the narrow spaces between the envelope's layers to cleaned them well. Otherwise, it is essential to find special devices to clean them from time to time, paying attention to the efforts and the costs of this matter.

(Maintainability of perforated panels)

		Yes	No
Q.60	Are the perforated panels easily maintainable/changeable?	**50 cases**	**10 cases**

The factors those influence the envelope's maintainability are: a) the recyclability of the perforated material, b) the clean-ability of the envelope's layers, c) the level of material's resistance to the climatic changes, and d) the changeability of damaged parts of the envelope.

Discoloration, rust, rot, buckling, deformation, fracture, etc., are some of the envelope's long-term problems, where they need for different maintenance and treatments will arise (Fig. 4.12, 4.13). These problems lead, in some cases, to the need for totally changing the damaged units/panels. Dependently, the maintenance of the perforated envelope can be considered as possible in most cases (50 cases), since the perforated envelope was divided into smaller panels where they are easy to install and to repair, which facilitates the maintenance process, even in the cases of great damages.

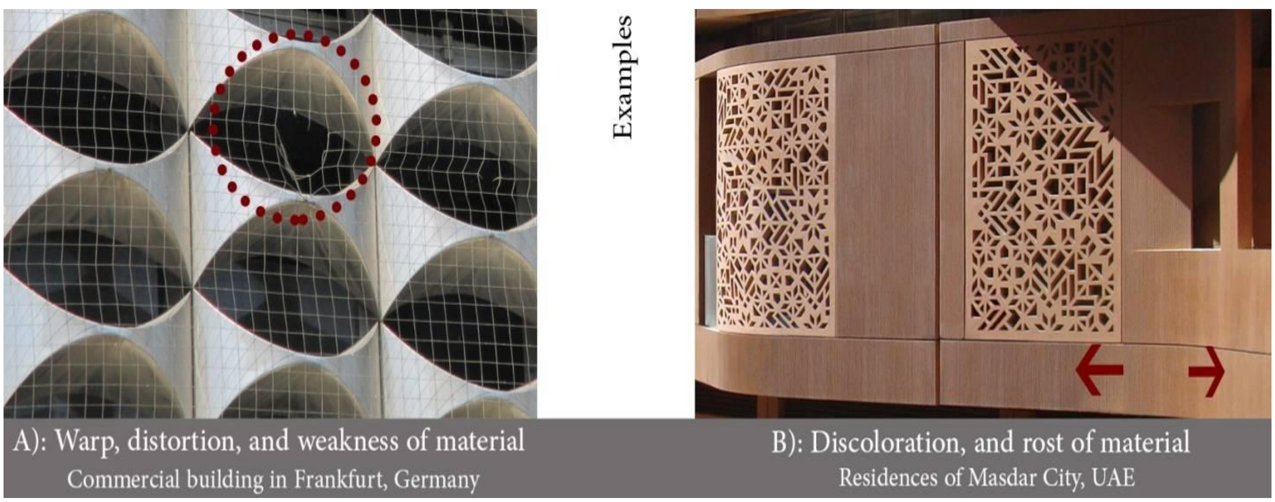

Figure 4.12: Examples of problems related to the perforated layers and perforated materials, left photo is a commercial building in Frankfort-Germany; right photo is Masdar City residences, (right photo reference: <http://www.aquapanel.com/inspiration/list-mode-by/>,(10/2015)).

In some cases, the maintenance is considered as difficult in the cases of using heavy perforated materials with no panels' division of the envelope's perforated layer (cast on-site), thus the maintenance process requires greater efforts and costs. Many other problems (i.e. wall fragmentation) may also affect the envelope's components' coherence. Dependently, the long-term problems need an attention in the design and maintenance plans.

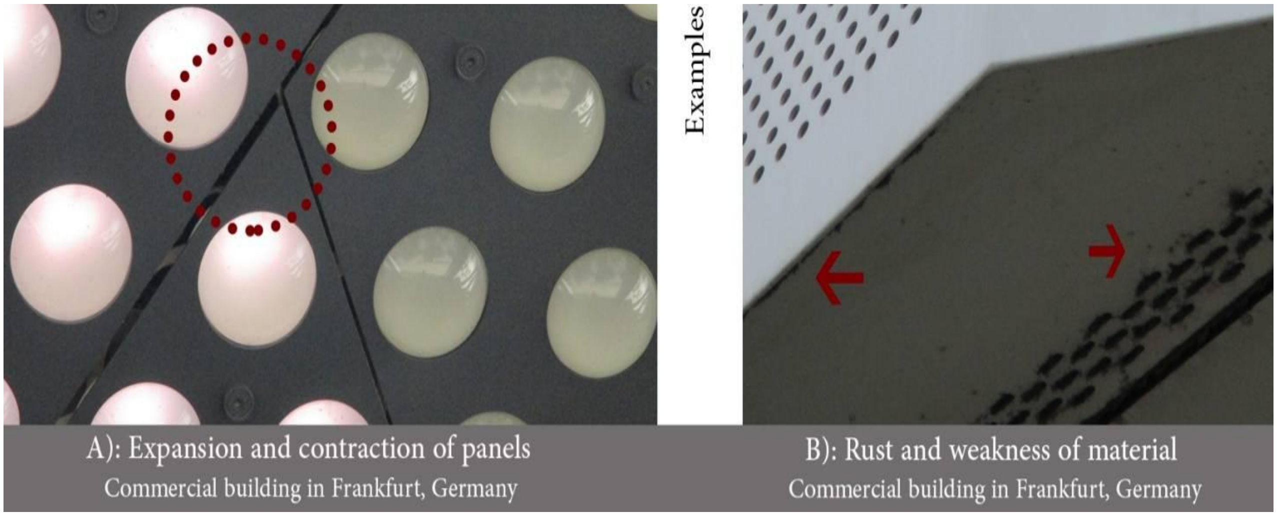

Figure 4.13: Examples of problems related to the perforated layers and perforated materials, commercial buildings in Frankfort-Germany.

4.3. Interrelations of outcomes

It is obvious that maintaining a sustainable building's envelope does not mean maintaining the sustainability dimensions separately. It can't be said that the envelope, for example, is environmentally sustainable but not socially, while it can be said that the envelope's design considers the environmental needs more than considering the social needs. Therefore, the design of sustainable building's envelope should consider the three dimensions together, where "together" doesn't mean maintaining all of them in separated processes, but by considering the intersections and interrelations of the three-dimensional integrated approach.

This is confirmed in the discussion of the analysis results. There was no single point or a question that can be answered or discussed separately without referencing other influential points. Intersections between indicators are too many, with a great dependency of each indicator on the others. Sometimes the interrelations and relationships are mutual, sometimes they are adverse relationships, and sometimes they are accumulative relationships. For example, the smaller perforation sizing has an adverse relationship with the viewability, while the smaller sizing has a mutual relationship with the visual privacy and thermal performance. Another example, the thick perforated layer has a mutual relationship with thermal performance and a mutual relationship with the possibility of dust accumulation and birds nesting, etc. The adverse, accumulative, and mutual relationships, can be changed; developed; or enhanced by the use of passive and active design techniques, such as the use of kinetic or smart building's envelopes, or by the reuse of traditional techniques in a new way, to maintain all of the occupants needs together regarding the seasonal climatic changes, and upon the occupants' desires, to enrich the sustainability of the envelope.

4.4. Potentials of envelope's perforation

As illustrated by this part, there is a great tendency to use the perforation in the contemporary buildings envelopes, which has been started by the beginnings of the twenty-first century and influenced by the presence of the digital technology, which contributed to some extent in the development of the architectural form and design of the perforated envelopes.

The use of perforated envelopes in the contemporary buildings is accelerating dramatically day by day, due to their environmental and aesthetic values. Therefore, if they were designed well, then the trend will take a greater interest in the future, otherwise, if they are not designed well to enrich sustainability, then it might cause a decline in the trend after a period of Post-occupancy experiences and evaluations. Hence, the analysis has focused on the philosophy of this architectural trend before a probable wider prevalence, to outline the possibility of benefiting from its potentials in a sustainable approach, to develop the envelope's functions in which the perforation has done since immemorial time, and not abandoning them.

All results clarify the several differences between cases by using different technologies; different building materials; and different forms and functions of perforation, in multiple climatic regions, without the presence of a clear evidence or criteria to guide this architectural trend. On the environmental level, the person can note a focus -to some extent- on taking advantage of the environmental benefits of perforation, while there are more profound environmental functions to be considered, as referenced in the results discussion.

It is clearly known that there are many ways and solutions those have been devised in connection with each of the environmental themes, construction, and technologies, in which they can be applied to the perforated envelopes. Therefore, the need here is to consider the sustainability dimensions altogether, by outlining the fundamental basis for the design of the perforated building in regards to the climatic zones.

The greatest need is to draw a greater attention towards the social- cultural and economic matters, to reduce costs and to enrich the relation between man and his environment and culture, and to resiliently appropriate the results on reality by taking advantage of what has been in the cases of traditional perforations, as addressed in the theoretical part. Dependently, the potentials of perforation can be translated to a sort of guidelines as clarified in the next chapter.

CHAPTER 5

GUIDELINES FOR DESIGNING THE PERFORATED ENVELOPES

5.1. The building envelope's design

The building's envelope performs various tasks, including the protection from the wind, rain, irradiation, heat and cold, visibility and glare protection, fire protection, noise protection, and physical security. Where, at the same time, its design must fulfill the requirements for internal spaces, including thermal, acoustic, and visual comforts, along with the requirements for resisting humidity conditions for both comfort and for preventing mold and mildew growth (Zhivov *et. al.*, 2011). Architects and engineers have developed innovative new ways of improving the overall building's design in order to maximize the light and heat efficiency (i.e. passive solar heating to warm the building's interior) without relying on any mechanical or electrical equipment (Climate Tech Book, 2011).

There is a great potential in taking passive design properties into account through the development of any architectural concept, which demonstrates that integration of technical knowledge at the early stages of design cannot only qualify the geometrical processing but also facilitates the design development of the façade (Nielsen *et. al.*, 2016). Accordingly, guiding the building's design saves time and efforts for the designer who is seeking to know and understand the main aspects those change the design process, in order to reflect local preferences in material use, design and construction, and regional climate differences, to reach effective design solutions.

Design guidelines facilitate the achievement of various efficient performances by following energy-efficiency codes and standards and ensure long-term durability of buildings. In addition to outlining the fundamentals of building's science and information (FP Innovations & RDH Building engineering, 2013). The local climate is an important determinant for identifying the design features those result in reducing the energy needs, including various issues, such as south-facing windows in cool climates, and shading to avoid summer sun in hot climates, etc. (Climate Tech Book, 2011).

A holistic performance optimisation can be obtained by considering different design parameters, such as the façade's geometry and orientation; functional organisation; heights and depths; façade layout; window geometry and transparency; design of the window aperture; etc., to simultaneously maintaining high-quality indoor climate and also an architectural quality (Nielsen *et. al.*, 2016). Consequently, considering the guidelines for designing any type of a building envelope has a great significance for architects.

5.2. Guidelines extraction

Based on what has been discussed in this research, it has become important to highlight some significant guidelines to facilitate the design process of a perforated envelope of any building's type, which has not been addressed in any previous research so far. Therefore, the extracted guidelines are general, so they can be developed and customized in other research to be supported by different optimizations and simulations regarding the specific climatic zones and cultural regions.

The guidelines are extracted depending on the general understanding of the trend's potentials and making of the integrative holistic analysis. Dependently, the proposed guidelines are interrelated, crossing, and accumulative. Where they can't be separated from each other when it comes to achieving a sustainable perforated envelope. While they are listed in an order regarding the different categories (technological, environmental, etc.) to follow the already obtained sequence.

For carefully and deeply understanding of the guidelines sequence and encoding, each guideline is referenced to its question in the results discussion part, analysis and analytical sheets part, and the methodological approach part. Accordingly, the encoding was obtained to mention the related question number and the category type symbol. Therefore, the technological guidelines have the code G.TE., the environmental guidelines have the code G.EN., the socio-cultural guidelines have the code G.SC., and the economic guidelines have the code G.EC. For example, G.TE.15 represents a technological guideline which is related to the question number Q.15, and so on.

5.2.1. Technological guidelines

The technological aspects of the perforated envelopes bring major changes to the whole design of the building, including their direct and indirect effects on environmental, socio-cultural, and economic aspects. Dependently, a set of technological guidelines can be considered in the future design process of a perforated envelope as follows:

G.TE.1. *Intervention of perforation*

Perforation has significant potentials in both the construction of new efficient envelopes and the refurbishment of existent envelopes to become more efficient, as the perforation has different alternative materials, technologies, implementations, and roles those can fit the different contextual needs. While the perforations' design should regard, if doesn't enhance, the building's appearance and it's conceptual and functional values, and the community values and needs.

An example was proposed, in this regard, by Alatawneh and Germanà (2016), using the earthen perforated envelopes for making low-cost refurbishments for the partially destroyed houses during the attacks in Gaza, and even for enhancing the house envelope's efficiency in other regions of Palestine. Accordingly, these proposals can be valid for other similar cases in different countries, such as Syria, Iraq, Yemen, Libya, etc., after making certain contextual appropriateness.

G.TE.2. *Number of perforated facades*

No limits have been identified for the number of perforated facades in the same building, as they can be all perforated, fully or partially, to maintain better aesthetic values, if needed, besides maintaining the environmental and socio-cultural needs, and considering the total costs.

Accordingly, the aesthetics of a perforated envelope shouldn't negatively affect the environmental and socio-cultural roles of the envelope itself. Also, the aesthetics should regard the economic considerations of the individuals (the owners) and even the community. The design of a perforated envelope should constantly consider all the envelope's desired roles together (i.e. when the design follows the aesthetic values of the envelope, it should also consider the visual comfort, the acoustical comfort, thermal comfort, etc.).

G.TE.3. *Number of fully perforated facades*

Following G.TE.2, the full and partial perforations of the building's facades shouldn't result in creating solid zones in front of interior spaces those need daylight, natural ventilation, and visual connectivity with the outside, etc., in order not to deprive the occupants of their essential environmental and social needs.

Miraj and Martin (2013) said: *"We are not interested in complex form or architectural 'objects' that do not respond to the contingent or ordinary, but a deeper understanding of space and human experience. The void has a use value beyond the emblematic or minimal, it is a powerful and essential process of creation and sensation. So our focus is on making and the interplay between something and nothing, dynamic and static, darkness and light".* Accordingly, creating solids and voids into the perforated facade can be aesthetically accepted only if the interior spaces behind the solids have certain functions those don't mainly rely on the openness and visibility of the outside and the inside (i.e. museums halls, theaters, stores, galleries, etc.).

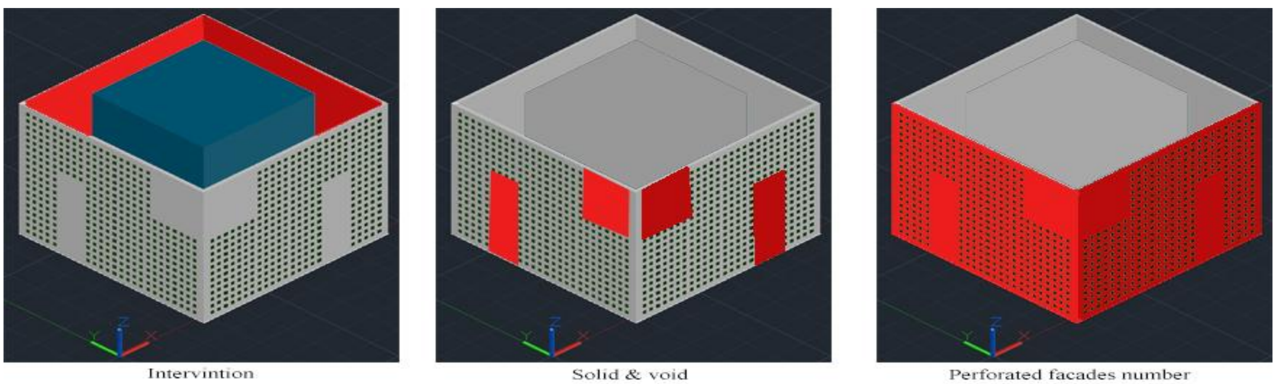

Figure 5.1: Illustrative drawings of the points G.1, G.2, G.3.

G.TE.4. *Orientation of perforated facades*

A systematic methodology of how to orient and where to locate the perforated faces should be carefully followed to increase the perforation's contribution in maintaining the environmental values of shading and getting natural light, whatever and whereabouts the facade is located or oriented. In the case of using one or two perforated facades, then they should follow their environmental function totally in regards to the climatic zone (i.e. a perforated facade in the arid region should be located in the hottest directions to decrease the effects of solar radiation and to reduce the thermal transfer).

Following point Q.27 in the subtitle 4.2.2, the perforated facade's orientation should regard both the azimuth and the altitude directions, where both directions are still significant to maximize the environmental benefits of the envelope's passive design and to play an integrated role in maintaining thermal and visual comforts (the orientation can affect the visual range) together in the different climatic zones.

G.TE.5. *Shapes of the perforated faces*

The flat-shaped of the external surface of the perforated facades is currently the most common used shape as it is easier in the implementation process, especially for the refurbishment works. Despite this, other shapes of the perforated facades surface can play a significant role in gaining or rejecting the solar heat (i.e. less than 90 degrees vertically-inclined or folded surfaces can reject solar heat, and more than 90 degrees vertically-inclined or folded surfaces can gain more solar heat).

In addition to the facade's shape itself, the inclination of the perforated layer has also a significant environmental role, either it was used to filter and control the sunlight passage, or as a layer that adds aesthetic or conceptual values to the building's envelope.

G.TE.6. *Number of the perforated layers*

Using more than one perforated layer can be thermally useful and it could increase the privacy levels, in some circumstances, but it could be visually critical in the case of static perforations, especially when each perforated layer has a different perforation pattern and a different perforation sizing. Dependently, this matter is an important aspect in the envelope's design considerations.

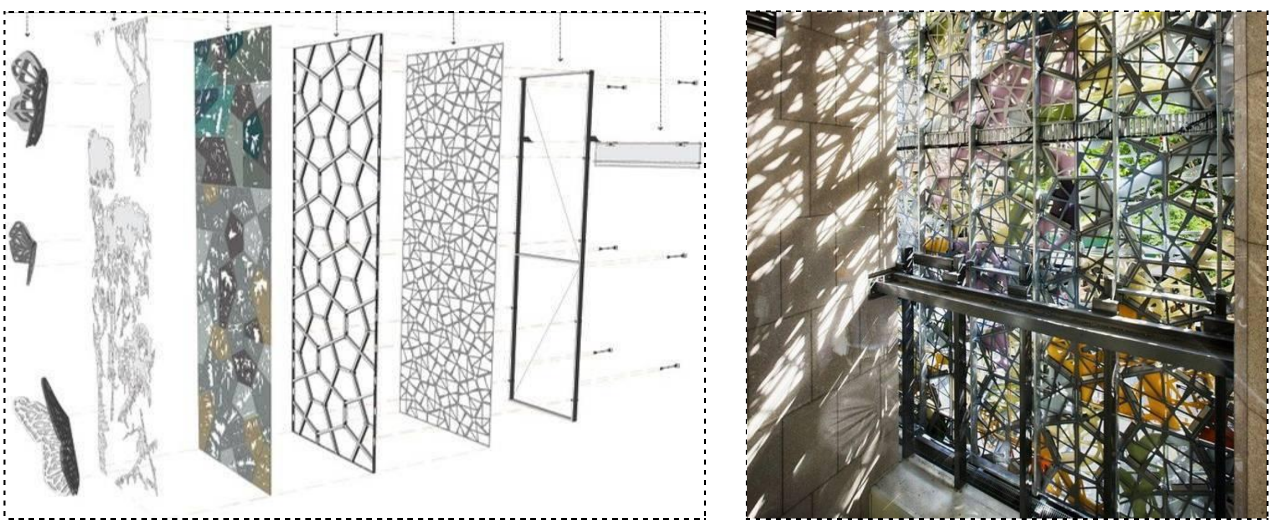

Figure 5.2: An example of multi-perforated layers in the same facade. <https://it.pinterest.com/pin/87468417738388138/>, (10/2016).

Despite all, this negative effects of using more than one perforated layer can't be influential for buildings where the visual contact with the outside is not highly needed (i.e. theaters, churches, sports halls, etc.). Where, creating more than one perforated layer within the residential buildings' envelopes is the most critical, as it must be treated cautiously without affecting the contact between man and the outside environment.

G.TE.7. *Roof perforation*

The building's roof perforation has no great emergence in the contemporary trend, unlike the traditional models of perforated domes and vaults those were created to get an indirect daylight, and to add other values (i.e. privacy) among the traditional architecture, which is undeniable (i.e. using the perforated domes in the traditional bathhouses to light the interior spaces besides maintaining higher level of privacy at the same time).

Despite that the contemporary roof perforation is limited to very few cases, due to different reasons, there is a possibility to design some perforated roofs in the future, to take use of their advantages by re-employing them in different ways, wherever it is possible, but by considering the local climatic conditions, and without affecting the building's possible vertical extension in the future, if needed.

Furthermore, the inclined perforated facades can play the same role of the perforated roofs, to some extents and in some circumstances, when the inclination angle is large as it helps to increase the direct sunlight transmission to the interior spaces when needed. The design of roof perforations can be treated, in some cases, in the same way as the skylights.

G.TE.8. *Perforated layer material*

Selection of the perforated layer material is one of the design basis, while the selection criteria should consider the different properties of the desired material (i.e. choosing material regarding its hardness, moisture resistance, humidity resistance, its availability in the local market, etc.). The selection process is complex, but it should consider the technical aspects of materials.

Using metals as perforated materials occupies the forefront in the contemporary trend, while it doesn't perfectly fit the requirements of all climatic zones, due to their relatively low thermal capacities. While, according to Mainini *et. al.* (2015), metal mesh performs worse than the glazing system alone in the Mediterranean climate, for example. Dependently, if they are selected, they should be treated to fit the local climate, otherwise, they should be excepted by using other efficient and innovative materials those have greater potentials in specific climatic zones.

The use of conventional building materials those definitely considered as noble and satisfactory material should take its place when it is possible, even they could be treated to fit the intended properties.

G.TE.9. *Creation method of perforation*

Perforation can be created by different techniques, and different methods, by using prefabricated perforated panels, by casting them on-site using specific molds, or by interlocking the units/blocks together on-site in a certain order to shape the perforations by leaving the small voids between the blocks. In this matter, it is important to pay attention towards the economic dependency and the costs of such techniques, in order to meet the individual's income level, or even to use the low cost solutions in the poor communities, whether the costs are about the implementation techniques, or about the costs of maintenance phases among the lifetime of the building.

G.TE.10. *Material behind/in front of the perforated layer*

Selection of the perforated material must be integrated with the selection of the material behind or in front of the perforated material, if applicable, to create compatible envelope's contents, technically, thermally, and structurally, taking into consideration the expansion and extraction of each material besides considering the thermal capacities and the needed thermal insulation.

For example, using glass behind the perforated metals in the double skin envelopes occupies the forefront in the contemporary trend, while would be a critical use in the case of using metallic perforated layer, in the hot climatic regions, due to the high thermal conductivity of metals and the ability of glass to transfer heat, if it is not highly reflective or suitably selective. Due to this, the design solutions of the perforated envelopes of several layers should consider the reduction of heat transfer and takes into account the compatibility between all of the selected materials.

G.TE.11. *Perforation pattern shape*

The perforation patterns have a huge number of alternatives, starting by the primitive geometries, to the floral or natural patterns, the natural patterns, the abstract patterns, the oriental patterns, the Islamic patterns, the symbolic patterns, etc. (Fig. 5.3, 4). Where the choice of a certain pattern refers to the designer's intention, but with a regard to the intended values.

Using the primitive geometries in the perforation patterns occupies the forefront in the contemporary trend, while it dismantles the building of its identity, and also dislocates the building from its local context. Dependently, the different conceptual patterns can take their places in the design process to indicate a sign of the local cultural identity within the building's envelope, and to give a meaning to the building's appearance at the same time, besides the aesthetic values.

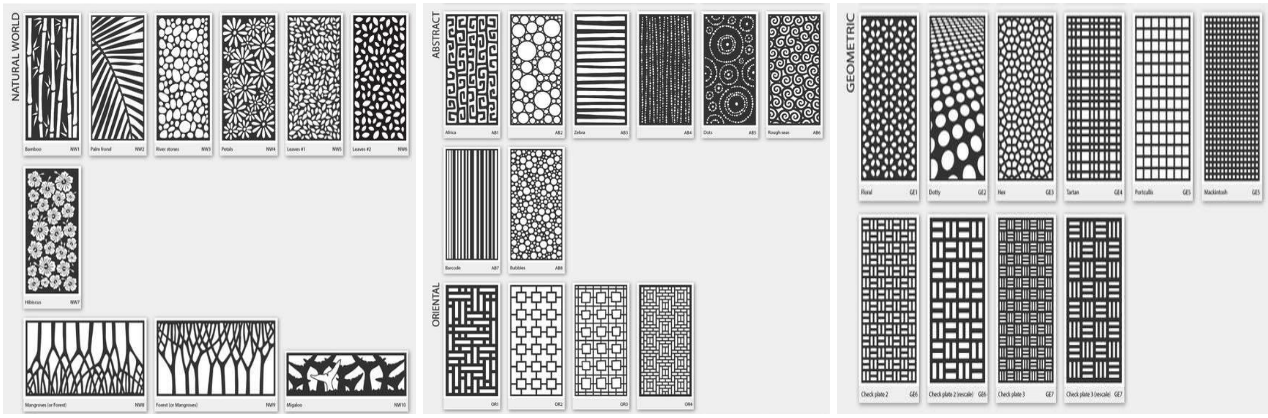

Figure 5.3: Examples of patterns; natural, abstract, oriental, geometric. <https://it.pinterest.com/pin/498140408765870774/>, (10/2016).

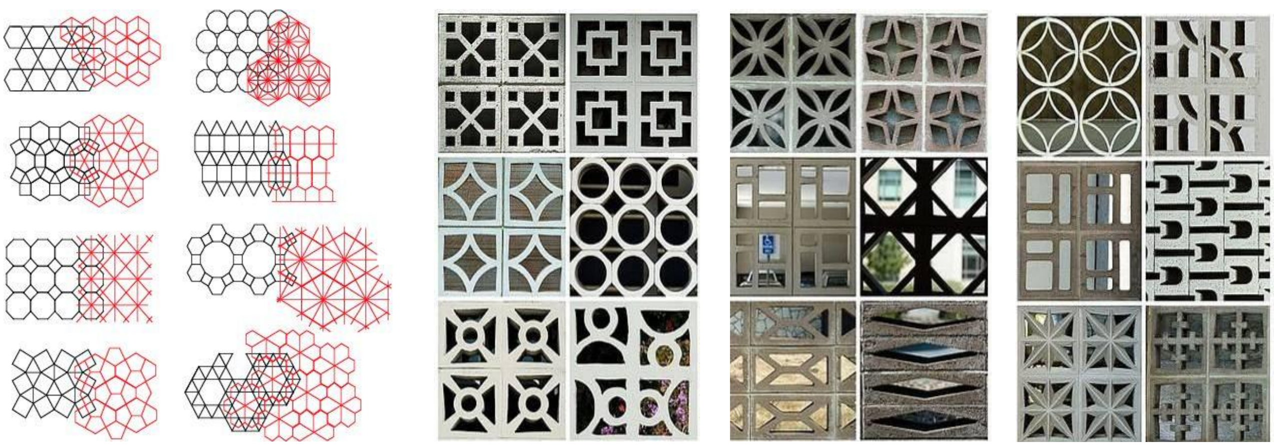
Figure 5.4: Examples of geometrical perforation patterns. Left photo ref. <https://it.pinterest.com/pin/293859944411915612/>, *other photos ref.* <https://it.pinterest.com/pin/122582421083547657/>,(10/2016).

G.TE.12. *Perforation sizing*

Perforation sizing has a great significance in the perforated envelope's design due to the high dependency of different design parameters, envelope's functions, and even other guidelines, on it. There are multiple choices of sizing of perforation (Fig. 5.5.), while for instance, the perforation size changes the percents of daylight transmission to the interior spaces, changes the amount of heat transfer between inside and outside, and affects the level of visual privacy and visual comfort (viewability in the case of static perforated layer).

Dependently, using the very tiny-sized and small-sized perforations (as categorized in the methodology part) shouldn't negatively affect the mentioned aspects and needs. Otherwise, the dynamic envelope's components will be a persistent need and should be considered through the design process, but also the viewability should be considered while closing the perforated layer for thermal needs.

Figure 5.5: Examples of perforation sizing. <https://www.architonic.com/en/product/interlam-art-diffusion-organica-screen/1076939>, right photo ref. <http://www.notcot.org/post/34658/Distance-of-fog-house-by-studiogreenblue-Through-multip/>, (9/2016).

G.TE.13. *Perforation's configuration*

The perforations' configuration over the perforated layer surfaces is related, to some extent, to the concept of solid and void distribution, due to the direct effect of the configuration on the openness ratios and the visibility, as if the configuration is regular, then the openness and the visibility would be regular, and vice versa.

Anyway, whether the perforation's configuration is regular or irregular, it should regard equally the functions of all interior spaces without depriving any spaces, if needed, of its basic environmental needs, and without negatively affecting the visual privacy, when needed, especially in the residential buildings, and more especially in the context of conservative communities.

G.TE.14. *Perforation ratio*

As clarified in the previous chapters (point Q.14 in chapter 3 and chapter 4), the perforation ratio has the same influential factors such as those the perforation's configuration has, but with different levels of effect, such as the influential factors related to the percents or voids and solids those affect the veiling-revealing issues, shading percentage, visibility, and openness, etc.

In the case of buildings those crucially need the daylight transmission, the perforation ratio should be linked to the openness ratio in order to determine the amount of daylight transmittance into the buildings while paying attention towards the socio-cultural values. Where the suitable openness ratio is approximately 35%, according to Cruse (2012). Overall, the determination of the perforation ratio is subjected to the local climatic parameters (i.e. the solar radiation) to determine for example the needed amount of daylight passage, to the building's use. It is also subjected to the needed level of privacy, and to the dynamism status of the perforated layer.

G.TE.15. *Perforated layer thickness*

The determination of the thickness of perforated layer lies mainly on three or more alternatives; one of them is the use of the internally solid perforated layer, the second one is the use of internally vacant perforated layer, and the third one is the use of flexuous (pliable) or twisted perforated layer (Fig. 5.6). The determination of the perforated layer thickness must be accompanied by the simulation of the thermal behavior of the choice regarding the chosen material.

The perforated layer thickness is mainly linked to the type of the used perforated material, where it plays a significant role in decreasing or increasing the thermal performance of the envelope itself, which in turns affects other environmental parameters, and even changes the costs. For instance, the thin perforated layers need certain treatments or solutions for decreasing heat transfer, especially for metallic materials, when needed, while for thick perforated layers, an attention should be paid to the technical issues such as preventing dust accumulation inside the perforations, insects gathering, and birds nesting; etc.

Figure 5.6: Examples of perforated layer thickness determination, by using both solid and nonsolid layers. References from left to right <https://www.architonic.com/en/product/erwin-hauer-studios-design-201/1210708>,<https://www.architonic.com/en/product/rieder-fibrec-3d/1196022>, <http://matsysdesign.com/studios/compositebodies/tag/installation/>, (09/2016).

G.TE.16. *Air cavity depth*

The double skin envelope is commonly used either for technical purposes, for environmental purposes, or for other different purposes (Fig. 5.7). The air cavity between the two layers in the double-skin envelopes can change the formula of heat transfer, especially that the cavity is ventilated by the perforations themselves, which can create a significant difference between the inside and the outside temperatures, in some circumstances. For this reason, the air cavity can be recommended in the case of using thin perforated layers, especially the metallic ones, to decrease heat transfer and to get rid of the absorbed heat and the heat transferred to the cavity.

Nevertheless, the important aspect is that the depth of the air cavity shouldn't negatively affect the occupants' visual comfort and the usability of the envelope's external layer, especially when it is manually controlled, also it shouldn't affect the maintainability of the envelope, it should be considered to be enough for making the periodic maintenance between the two layers, especially in the case of inaccessible air cavity (cavity for technical purposes).

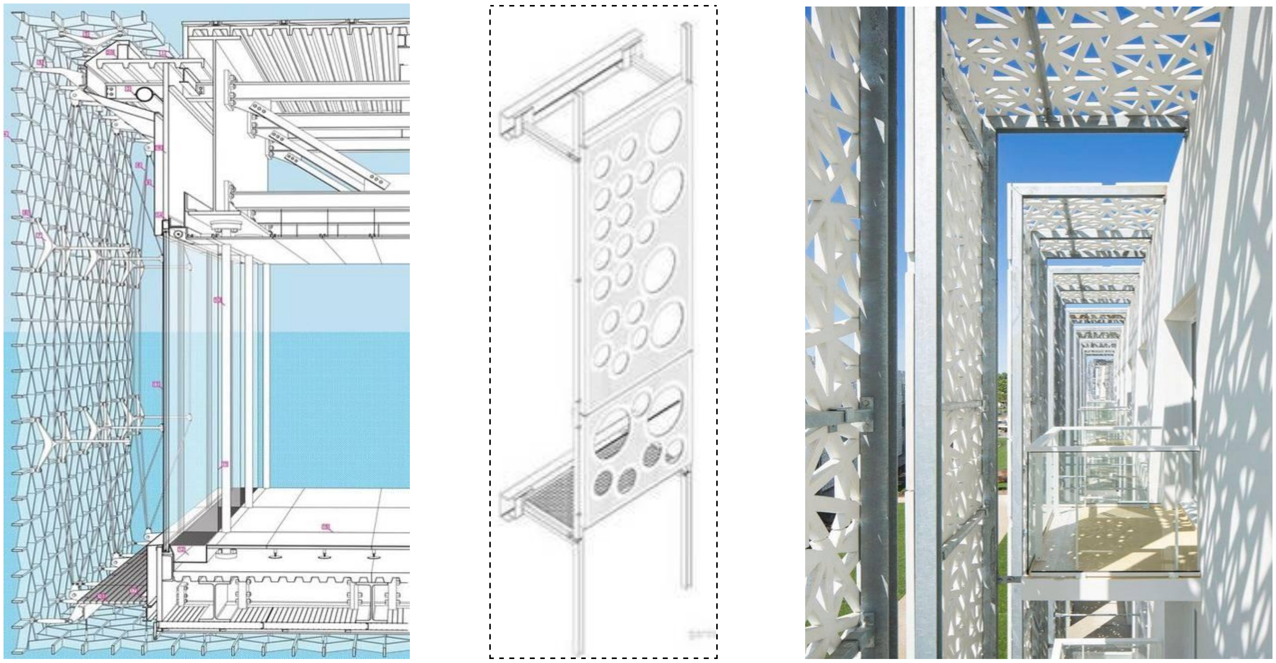

Figure 5.7: Examples of double skin perforated envelopes. References (left to right) <https://it.pinterest.com/pin/379850549800340674/>, <https://it.pinterest.com/pin/407223991279400488/>, <http://bestz.info/gallery-nakara-residential-hotel-jacques-ferrier-architectures-2.html>, (09/2016).

G.TE.17. *Dynamism of the perforated layer*

The dynamism of the perforated layer is crucial, whether it is a manual or an automotive dynamism, as it facilitates the production of an adaptive facade that regard the daily or seasonally changing occupants' needs. The perforated envelope could be partially kinetic, by using some moveable segments within its external layer, or it could be fully kinetic, by using larger moveable parts of the envelope's external layer.

The static perforated envelope could, directly and indirectly, affect the visual comfort level and the direct connectivity of occupants with the outside, to some extents, depending on the perforation sizing, perforation ratio, the air cavity depth, the perforation configuration, and also the building use.

G.TE.18. *Complementary openings*

In regards to G.TE.17, the use of static perforated layer can be considered as a feasible solution when the envelope has some complementary openings, other than the perforations themselves, such as in the case of using the static Mashrabiya in the traditional architecture. Those complementary openings can be used for both the partially and the fully perforated envelopes, except when the function of the building has no functional need for those openings, then the static envelope choice could be feasible. For partially perforated envelopes, using windows alongside with the perforation can support the achievement of the desired levels of visibility, visual comfort, thermal comfort, etc. Where the static perforated layer doesn't achieve them alone, mostly.

5.2.2. Environmental guidelines

The environmental aspects of the perforated envelope are totally interrelated to the technological aspects, which in turns, brings changes to socio-economic and socio-cultural aspects of the envelope. Dependently, a set of environmental guidelines can be considered in the design process of a perforated envelope as follows:

G.EN.19. *Intention for perforation*

The envelope's perforation has several potentials to be effectively employed within the design process, depending on the designer's intention. Those potentials are environmental, socio-cultural, economic, aesthetic, etc., where the designer can decide to employ one, two, or all of them together, to meet the intended needs of the building's occupants, to contribute to the achievement of health environment, or to ensure the architectural identity.

The different intentions and purposes of today are considering mostly one or two of these potentials which weaken the function and the concept of perforation, in some cases, contrary to its integrative functions of the perforated models among history. For contributing to the achievement of sustainable buildings, the perforated envelope's design should consider all of these potentials together, when it is applicable or needed.

G.EN.20. *Orientation purpose*

Following G.TE.4, the orientation of the perforated layers can have different purposes or intentions, they could be environmental, conceptual, or inevitable (when the building is located in a row of adjacent buildings with zero setbacks).

Despite these different purposes, considering the environmental orientations of the facades adds a value to the perforated envelope's function. In case of inevitable orientation of the perforated facades (i.e. row-houses), the environmental function can be employed indirectly, which for example, can be achieved to some extent by changing the rotational angles of the perforations themselves (Fig. 5.8), vertically or horizontally, statically or dynamically, to increase the benefits from the sunlight or to reject the excessive solar heat, etc.

Figure 5.8: Illustrative examples of changing rotational angles of the envelope's perforated layer. References (left to right),< https://it.pinterest.com/pin/426223552216021729/>,<http://www.archdaily.com/620039/local-house-make-architecture>,< http://4.bp.blogspot.com/-vA7kzOokaCY/UYUUcqzBMnI/AAAAAAAAAPo/9pTxPwEoluw/s640/Render+3.0127.jpg>, (09/2016).

G.EN.21. *Daylight transmittance*

Several parameters of the perforated envelope's design can change the amount of daylight transmittance to the interior spaces, starting by the perforation sizing, the perforation configuration, the perforation ratio, the open ability of the envelope's components, the existence of complementary openings, etc.

According to Sherif *et. al.* (2012b), the solar screens have the potentials of improving the illumination level and reducing the occurrence of glare phenomena. Due to this, and for a suitable daylight transmittance and visibility, the perforation and the openness parameters have mutual relationships those should be intentionally determined together to achieve the required amount of daylight's transmission following the building's use and the internal spaces functions, regarding the standards of the buildings' design.

G.EN.22. *Natural ventilation*

The natural ventilation depends mainly on the dynamism status of the envelopes parts and the openable components such as windows. For static perforated envelopes, the natural ventilation should be enhanced either by the perforation techniques themselves, by using the openable windows in the inner envelope's layer, or by using other integrative ventilating systems, in order to decrease running costs of artificial ventilation and to maintain healthy internal environment, except for some buildings those don't need connections with outside environment (i.e. theaters, opera houses, etc.). Accordingly, the natural ventilation process can be easily considered in the design process of the building's envelope without any complex intersections with other functions or intentions of the perforated envelope.

G.EN.23. *Perforated material's source*

Using conventional materials for creating the perforated layer helps in decreasing the initial costs of the envelope, besides adding values of nobility to the envelope. While, this does not obviate the use of innovative low-cost materials unless it doesn't conflict with the environmental quality and the general appearance of the building in regards to its context. For example, some new materials have multiple benefits such as maintaining higher resistance to the climatic changes and imparting a novelty to the building's envelope, which in turns, enhances the envelope's performance. Accordingly, the door for creation remains open, but the costs and the architectural identity are still considerable aspects.

G.EN.24. *Thermal capacity of the perforated material*

The thermal capacity of the perforated material can be considered as a selection priority. Selecting the suitable perforated materials of high thermal capacities regarding their heat conductivity; heat reflectance, and heat absorbance is an important step for a thermal enhancement design process. The chosen material should fit the local climatic conditions by its resistance to the moisture, humidity, low thermal transfer, etc., but also an attention should be paid to the other properties those are related to the implementation, appearance, and maintenance. For this reason, specific treatments can be made for some materials to benefit from the different positive properties together.

G.EN.25. *Insulation within the perforated layer*

Following G.TE.15, the internally solid or vacant perforated layers can include different types of thermal insulation or moisture insulation, to enhance the envelopes performance. Generally, the traditional solar screens have proven their effectiveness in controlling the solar radiation and preventing the incidence of undesired glare resulted from the daylight, especially in the desert or the arid regions (Sherif *et. al.*, 2012). Consequently, in the case of using perforated materials of low thermal capacities within the envelope, suitable insulators and insulation techniques and even the waterproofs should be determined well in the design process.

G.EN.26. *Insulations within the layer behind/ in front of perforation*

Using the insulations within the envelope is an important aspect when the thermal transfer between inside and outside is high, or when the perforated layer is not treated to reject the solar heat, or when the envelope's layer behind the perforation has low thermal capacities. In the case of using a glazed layer behind a perforated layer containing a material of low thermal capacity, then a suitable thermal insulator or insulation techniques should be considered within the perforated layer or within the air cavity, if possible. Otherwise, alternative perforated materials or certain glazing systems should be considered. According to Gelesz and Reith (2015), the outdoor air curtain and ventilated box type window with shading, show cooling energy savings compared to the double glazing alternatives, and also performs better than the triple glazed façades while maintaining the same thermal comfort.

G.EN.27. *Shading percentage*

Following the technological guidelines, the perforated screens provide a shading percentage depending on the perforation sizing, the perforation ratio, the perforation configuration, the envelope's orientation, the perforated layer thickness, and also the perforations orientation (G.20).

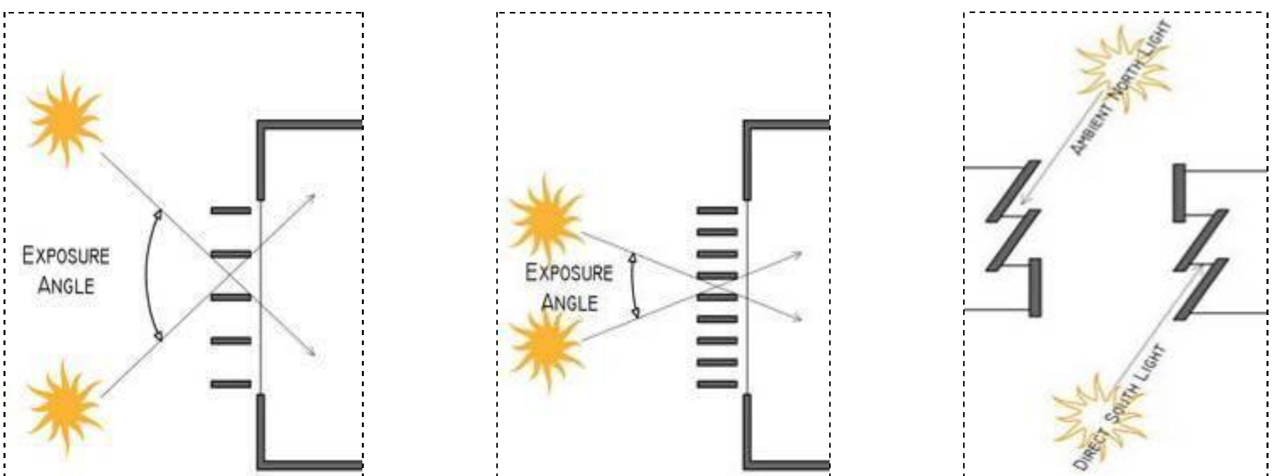

Figure 5.9: Illustrative examples of changing rotational angles and the depth of the perforated layer to receive or reject sunlight. <http://www.steelhouse.info/index.php/en/90-tech-en/227-radiation>, (10/2016).

The proportion between the hole's size and the perforated layer's depth, and also the orientation, change the percentage of shaded areas behind the perforated layer, controls the sunlight transmittance to inside, determines the possibility of birds nesting, determines the possibility for dust accumulation and insects gathering, etc. Accordingly, this proportion should be deliberately considered, without leaving its design intention for just the aesthetic purposes only.

G.EN.28. *Moisture resistance*

The perforated material should be selected to be suitable for resisting the moisture or the humidity, if needed, to maintain a durable envelope, which is related to the climatic zones and the exposure to the humidity or the rainfall. Otherwise, it should be treated by different technologies by the manufacturer without high increasing of the cost (i.e. galvanization, coating, developing the mixtures, etc.).

G.EN.29. *Decreasing heat transfer*

Following all of the previous guidelines, all of the perforation sizing, perforation ratio, perforated layer's material and thickness, air cavity depth, orientations, and insulation, should be considered altogether without any exclusions or exceptions in the early design calculations, and simulations, etc., for enhancing the envelope's thermal performance to control the heat transfer.

G.EN.30. *Passive design strategies*

Perforation doesn't eliminate the use of other passive design strategies (i.e. living walls, planted walls, ventilated facades, solar chimney, wind catchers, courtyards, Mashrabiya, sunshades, etc.) those can play a significant integrative role alongside with perforation to maintain a sustainable building envelope's design (i.e. the buffer mode box type window performs better than the double-glazed facade (Gelesz and Reith, 2015)). These strategies should be carefully included in the design (i.e. the solar chimney can work alongside the perforation for enhancing the cross ventilation). Furthermore, the perforated layer itself can be a passively adaptive layer, to save the operational costs, and to decrease the maintenance costs.

G.EN.31. *Envelope's dynamism*

The dynamism of the perforated layer is important to meet the occupants' desirable needs over the daytime, from day to day, or over the seasons. The perforated envelope's layer can have manually movable parts, or mechanically kinetic parts including the smart automation (Fig. 5.10).

The manually, electro-mechanically and smartly automotive process of the external layer play a significant role in producing passively or actively adaptive and responsive envelopes. While an important attention has to be paid towards the employment of renewable energy systems within the active design strategies, in order to decrease the operational costs of the envelope, and to reduce the Co2 emission.

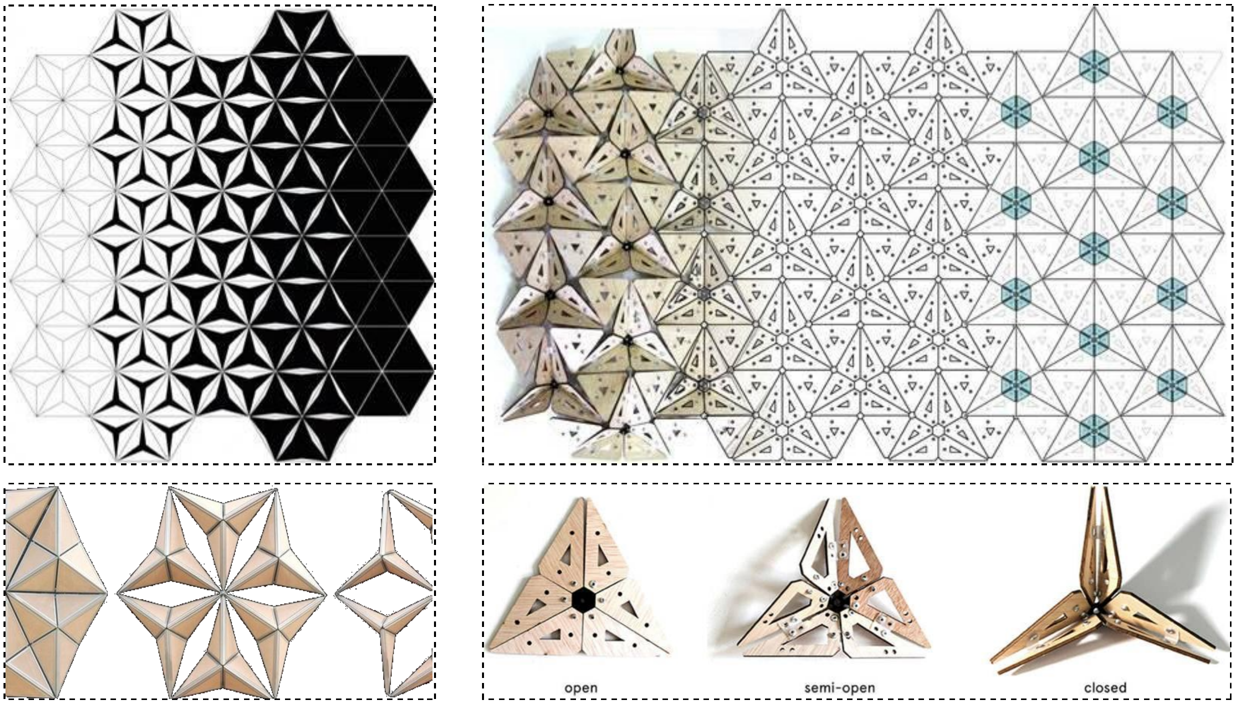

Figure 5.10: Illustrative examples of kinetic perforated envelopes, as new interventions of the Mashrabiya. References (right to left), <https://it.pinterest.com/pin/420594052678821766/>, <https://it.pinterest.com/pin/388857749050450375/>, (10/2016).

G.EN.32. *Energy norms*

The clean energy and the environmental-friendly materials and technologies should be highly considered and employed in the design of perforated envelopes, in order to save the environment and the natural resources. This is generally related to the building itself, while the use of renewable energy systems within the perforated envelope itself is possible in the future developments (i.e. installing some tiny moveable solar cells to fit the perforation pattern shape, in some places of the envelope). Accordingly, this matter has the potential to be highly focused in the future, which in turns contributes to the achievement of sustainable building envelopes.

G.EN.33. *Energy saving*

Generally, the perforated layer within a building's envelope decreases the of use needed energy for heating and cooling the building, to some extent, due to its thermal benefits. While, it is important to increase that extent to the desirable limit by producing more thermally-efficient and functional perforated layers those follow the requirements of the local climatic conditions.

For example, according to Mainini *et. al.* (2015), the metal meshes are never the best solution for solar strategies in some of the Mediterranean cities (i.e. Palermo city, Italy). Dependently, the selection and design criteria of the suitably perforated envelope must consider the several related aspects to maintain an effective design solution.

G.EN.34. *Manufacturing and construction technologies of perforation*

Construction and implementation technologies of the perforated panels have several alternatives, due to the successive developments and innovations within the digital technology by creating new complex parametric shapes and new materials production, day by day (Fig. 5.11). Some of the contemporary perforation technologies are considered as innovative, and some of them are still common, while both of them should be environmentally acceptable and economically feasible, in order to generalize and disseminate them in the local markets, to be available among the people of different economic abilities, and not to be limited to the production of expensive buildings' envelopes only.

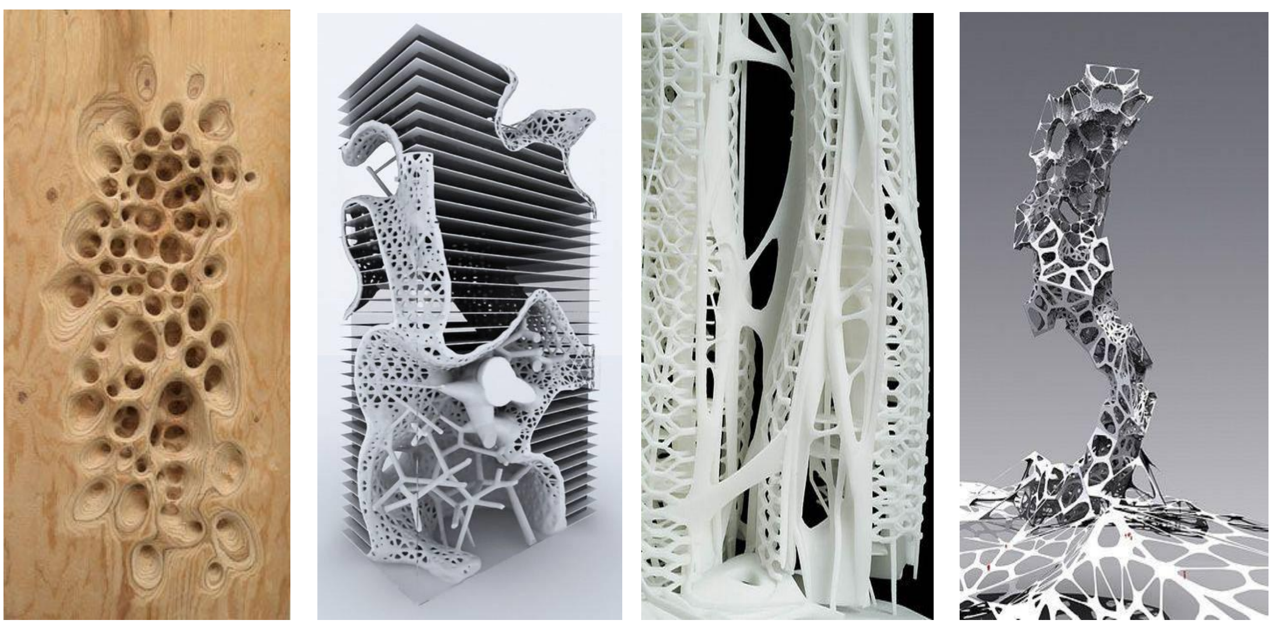

Figure 5.11: Examples of new proposals of complex parametric shapes. References, <https://it.pinterest.com/pin/333970128589041432/> <https://it.pinterest.com/pin/376402481336796864/>,<https://it.pinterest.com/pin/191543790374484300/>,<https://it.pinterest.com/pin/50236253 3408584454/>, (10/2016).

G.EN.35. *Awarding and certification*

Awards and certificates those were given to some perforated buildings (i.e. LEED certification) prove the potential of perforation techniques in the environmental design process, while a certain attention should be paid to the project's local socio-cultural context, the post-occupancy phase evaluation, and also the long-term evaluation. This is to ensure that the design led to a really sustainable solution and not only a periodic energy saving solution.

G.EN.36. *Active design strategies*

This is to confirm the guidelines G.EN.30-33. The active design strategies have many possibilities to be carefully included in the design of a perforated envelope (i.e. nanotechnologies, smart mechanisms, etc.), where those strategies can be employed more efficiently when taking the advantages of the renewable energy systems to maintain a sustainable perforated envelope, and without only relying on the non-renewable energy to operate a dynamic perforated facade / envelope.

5.2.3. Socio-cultural guidelines

The socio-cultural aspects of the perforated envelope are totally interrelated to the technological and environmental aspects, which in turns, bring changes to the socio-economic aspects of the building's envelope. Dependently, a set of socio-cultural guidelines can be considered in the design process of a perforated envelope as follows:

G.SC.37. *Cultural symbolism*

The perforation has a potential of easily expressing the cultural identities of the local context within the building's envelope, by the formation of perforations, their patterns, and orders, materials, etc. In this regard, a great lesson can be learnt from the traditional perforated models, especially the Mashrabiya which has a dominance interpretation in the contemporary architecture, where the contemporary metaphors of the Mashrabiya shouldn't dislocate it of its social context and deprive it of its cultural meaning (the veiling concept), paying attention to its integrative functions.

G.SC.38. *Material and context*

Keeping the building harmonious with its context and the spatial urban structure could be firstly achieved by selecting suitable envelope's material that reflects the identity, or it can be modified using suitable colors, textures, and other related properties to show an integration with the surroundings, if needed. This consideration can contribute, to some extent, in adding cultural values, those are disappearing, to the perforated envelope, or even to the building itself.

G.SC.39. *Accessibility of the air cavity*

The air cavity in the double-skin envelopes can't be only limited to the technical purposes, it can be also employed, such as several cases, as a transitional social space which connects the inside and the outside of the building by keeping the perforated layer acting as a veil or as a solar screen that shades the occupants while setting there (chapter 2 has a deeper clarification of this issue). According to Germanà *et. al.*, (2015) and Alatawneh & Germanà (2016), the accessibility of this air cavity is important to make use of this functional and transitional space, also to keep the occupants physically in touch with the perforated layer to control its dynamism, where they can open/close the perforated layer's parts upon their desires to maintain better visual comfort and to facilitate the envelope's maintenance.

G.SC.40. *Perforation sizing and view-ability*

The perforation sizing has an inverse relationship with the occupants' viewability to the outside. For example, according to Mainini *et. al.* (2015), a metal mesh system with wide-spacing ensures better outside view and a low energy use, excluding the glare.

According to this, the issue of viewability should be considered in the design process, when needed, as the visual contact between inside and outside should be kept possible for occupants, either by avoiding the static external perforated layers, by avoiding the very tiny-sized perforations (Fig. 5.12, middle), or by other suitable and innovative design solutions those enhance the viewability be using certain techniques.

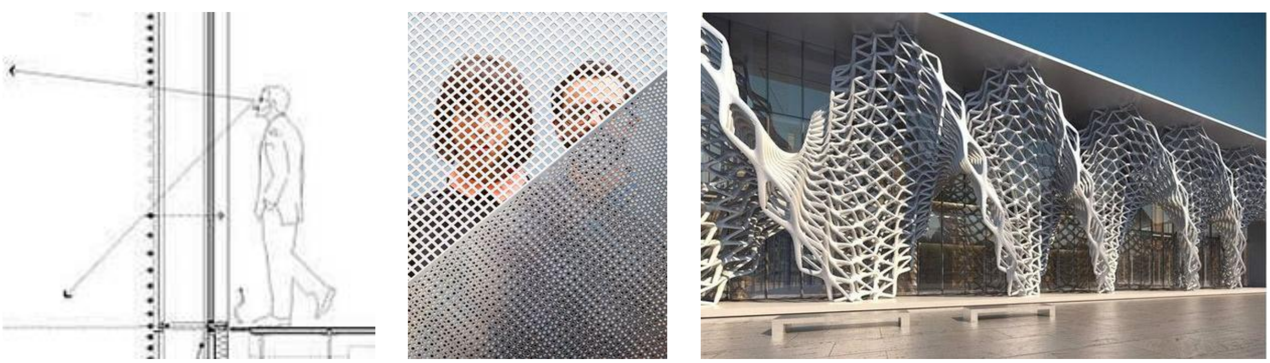

Figure 5.12: The effects of air cavity (left), perforation sizing (middle), and the perforation configuration (right) on the viewability. References,<https://it.pinterest.com/pin/222365918891336 15/>,<https://s-media-cacheak0.pinimg.com/236x/56/c6/dc/56c6dc6959eb93e108b4b84a346a803b.jpg>, <https://it.pinterest.com/pin/130956301644160504/>, (10/2016).

G.SC.41. *Air cavity and viewability*

The depth of the inaccessible air cavity (in the double skin envelopes) has an inverse relationship with the occupants' viewability to the outside. This issue should be also considered alongside with

G.40 and G.42 in the design process as they are integrative issues, either by avoiding the static perforated layers (avoiding the cage form, as clarified in chapter 2), by avoiding the very tiny-sized perforations, by using other suitable design strategies, or by considering the accessible air cavity which eliminates the distance between occupants and the outer layer of the envelope, if applicable (Fig. 5.12, left).

G.SC.42. *Perforation configuration and viewability*

Following G.SC.40 and G.SC.41, it should be confirmed also that the perforations' configuration shouldn't be only as an aesthetic design aspect, but also it has a functional value of providing veiling and revealing at the same facade (Fig. 5.12, right), which should be employed without affecting the occupants' viewability to the outside.

G.SC.43. *Perforation configuration and visual privacy*

Veiling and revealing of the building's occupants from outside was successfully controlled in the traditional models of Mashrabiya by carefully deciding the suitable perforation ratio, the perforation configuration, and other techniques. The level of visual privacy depends on the community culture, where it should be considered according to its desired level.

The perforations' configuration plays a significant role in increasing the visual privacy for some interior spaces and decreasing it for others within the same facade, depending on the needed level of visual privacy for each space (i.e. the needed level of visual privacy in a bedroom is greater than a guests' room). This matter can be suitably considered in the design process to follow the occupants' comfort.

G.SC.44. *Perforation and acoustical comfort*

Theoretically and based on the sound theories those are related to the sound absorption, reflection, and transmittance into the porous surfaces (Lamancusa, 1990), there is an inverse relationship between the noise absorption and the proportions of perforation size to the perforated layer thickness, as the smaller hole's size and the larger layer's thickness help in decreasing the sound transmittance to the interior. This relation enhances the acoustical insulation and acoustical comfort, if considered well. While an attention should be paid to the non-preferred echo which may occur inside the air cavity in the double-skin envelopes.

G.SC.45. *Air cavity and verbal contact level*

It is clear (as mentioned in chapters 1, 2) that the verbal contact with the outside of the building, such as the verbal contact between women in the houses on both sides of the street, was carefully considered in the traditional Mashrabiya model taking care about the visual veiling level at the same time.

The depth of inaccessible air cavity within a static perforated layer may inversely affect the occupants' verbal contact with the surrounding community and the public life, while the accessible one can mutually enhance this verbal contact. This issue should be quietly considered in the design process to enrich the social ties between man and the community, when it is preferable or needed, by suitably making use of the Mashrabiya, not only by interpreting its physical form or its thermal functions.

G.SC.46. *Perforation and the physical security*

Using rigid, stable, and wind resistant perforated layers with suitable perforation sizing can produce a preferable type of a physically protective envelope, which in turns increases the level of occupants' physical security, or even it enhances their feeling of security and safety, which is an important psychological factor. Thus, paying attention to the design of safe and secure envelopes strengthen their intended functions and their overall efficiency.

G.SC.47. *Perforation and visual privacy*

According to the previously clarified points, and generally speaking, the envelope's perforation increases, relatively, the levels of visual and acoustical privacy to some extents, in comparison with the transparent buildings' envelopes. While there are no significant inverse or mutual relationships between the visual and the acoustical privacy, they are independent.

Therefore, the intended level of visual privacy depends on the building's use and the culture of the local community, where the visual privacy is more important within the conservative communities, as it should be highly considered in the design process, especially for the residential buildings more than the public ones, and more especially for houses those are located in congested neighbourhoods.

5.2.4. Economic guidelines

The economic aspects of the perforated envelopes are accumulative aspects depending on the technological, environmental, and socio-cultural aspects. Where these aspects can increase or decrease the economic feasibility of the perforated envelope, depending on the costs of the obtained technologies, materials, and strategies. Dependently, a set of economic guidelines can be considered in the design process of a perforated envelope in order to decrease the initial and operational costs, and even the costs of maintenance, as follows:

G.EC.48. *Perforated material costs*

The initial cost of building materials refers to the embodied energy required to extract, manufacture, transport, install, and dispose of the materials, including those used in the building's envelope. Efforts to reduce this energy use and associated emissions, for example through the substitution of bio-based products, can be made as a part of a larger effort to reduce the emissions from buildings (Climate Tech Book, 2011).

The initial costs of the perforated materials, especially those are used in the fully perforated envelopes, can change enormously the building's construction costs. Therefore, the low-cost materials should be highly considered to comply with people's different economic abilities in the local community, and even to reduce the energy use, if those materials have suitable structural and environmental properties. Otherwise, other innovative economic alternatives should be considered.

G.EC.49. *Costs of perforation techniques*

The perforation can be produced and implemented by using different alternative techniques, some of them can be cheap and others can be very expensive. While considering the low-cost techniques and technologies during both the production and the implementation processes to provide the preferred perforated panels, can encourage people those have different economic abilities to consider these solutions, materials, and technologies within their own buildings, whether the public or the residential ones. This, in turns, gives a significant potential to the trend in the future, especially when disseminating a successfully designed model as a suitable model to be used in a certain context.

G.EC.50. *Operational costs of envelope's dynamism*

Apart from its initial costs of the perforation and following what has been discussed before, the dynamism of a perforated layer, whether it is fully or partially kinetic, can be manual, electromechanical and smart. Where the non-manual dynamic envelopes increase the operational costs of the building, especially when the obtained energy norm is non-renewable.

Accordingly, the low-cost operational processes should be considered for low economic communities and even for individuals of the low-income level. This can be considered by enriching the use of passive design strategies or by the employment of the clean energy to operate the building's envelope parts.

G.EC.51. *Perforation strategies and the operational costs*

Generally, the perforation technique decreases the thermal transfer between inside and outside the building, besides providing shading to the inner layer of the building's envelope, in the double skin cases, and even it enhances the mechanism and the function of the ventilated façades. Thus, the perforation strategy helps in decreasing the operational costs those are related to the needed energy to ventilate, to cool, or to warm the building's spaces, while this issue is not valid for all cases of perforated envelopes. Despite this, the costs of perforated envelope's dynamism, maintenance, and repairs, should be also determined to be less than the costs of saved energy. Otherwise, the adopted perforation solution will not be economically feasible.

G.EC.52. *Durability of the perforated material*

There are several reasonable properties of the perforated material those should be considered in the selection process, such as; its rigidity, hardness, moisture resistance, stability, thermal expansion and contraction, buckling and deformation resistance, rust resistance, fungal growth resistance, discoloration properties, and fragmentation resistance. These properties have to be carefully determined and considered during the design process, in order to maintain a durable perforated material, where most of these properties are subjected to the local climatic conditions (i.e. depending on Blanco *et. al.* (2014), the galvanized steel sheets reached temperatures of 4-5 °C higher than the anodized aluminium sheets, and the black-painted sheets perform with temperatures of 6-8 °C lower than the white lacquer-coated sheets).

G.EC.53. *Local availability of the perforated material*

To confirm what has been mentioned before, for decreasing the perforated material's initial costs, a specific consideration should be given to the locally available materials, especially the conventional ones, those have different economic, environmental, and cultural potentials to be used within the perforated envelopes. Considering at the same time the possible low-cost modifications those can be made for different types of materials in order to improve their properties to comply with the local climatic conditions. Regarding this issue, examples have been proposed and clarified by Alatawneh and Germanà (2016), and Germanà *et. al.* (2015).

G.EC.54. *Rainwater penetration*

To immediately get rid of the rainwater that penetrates into the air cavity through the perforated layer, the double-skin envelope should be dried quickly by diffusion and ventilation, using some suitable design techniques or strategies (i.e. using downward inclined perforations, developing the ventilated facades, etc.). some consideration, may be by using insulations, should be also given to the design of single skin envelopes. This helps the envelope's system to prevent moisture happening, insects gathering, mold and mildew growth, etc.

G.EC.55. *Dust accumulation*

Avoiding thick perforated layers with very tiny-sized perforations is not the ideal solution for decreasing the possibility of dust accumulation and insect's proliferation inside the perforations. Where the technical design of perforations can prevent those problems to some extent, by considering special economic techniques (i.e. using internally cleanable perforated surfaces, smooth surfaces, and internally inclined or curved perforations where the dust accumulation would be difficult).

G.EC.56. *Birds nesting*

The common technique of installing some pins to prevent the birds' standing or nesting over a building's facade, or an envelope's openings, will not be a suitable solution to be obtained for the perforated envelopes by installing some pins inside each perforation. This is not the only technical solution for preventing birds nesting, it should be considered as the last choice. Where, the perforation design itself should include certain technical strategies to prevent this problem (i.e. considering the inclined perforations where the bird can't stand or nest inside them).

_G.EC.57._ _Recyclability of the perforated material_

The recyclability of the perforated material is quietly significant for decreasing the environmental problems those related to getting rid of the demolished constructions' materials. Considering recyclable perforated materials contributes, sometimes, in decreasing the environmental problems, end even facilitates the maintainability and changeability of the destroyed or the corrupted parts of the perforated layer, after a possible periodic change.

_G.EC.58._ _Cleanability of the perforated layer_

Clean-ability of the perforated envelope is important to be considered in order to deal with a possible dust accumulation or spiders and insects gathering inside the very tiny or deep perforations, or inside the air cavity itself in the double skin envelopes. Unclean-able perforated envelopes distort the overall appearance of the building and gives the possibility for fungal growth or insects gathering. To avoid this, an importance should be given for finding, within the design process, some certain technical treatments for the perforations sizing, shapes, surfaces textures, layers thicknesses, material's types and properties, etc.

_G.EC.59._ _Cleanability of the layer behind the perforation_

Similar to the perforated layer, as clarified in G.58, also the clean-ability of the layer behind the perforation should be considered. The narrow inaccessible air cavity should be avoided, if possible, in the design of double-skin perforated envelopes, in order to avoid the cleaning and maintenance problems. Otherwise, the envelope's perforated layer or the internal layer should contain some moveable parts to easily clean them and repair the possible technical problems happen into the air cavity.

_G.EC.60._ _Maintainability of the perforated panels_

The main aspects those should be considered for designing and implementing a maintainable perforated envelope are: a) the recyclability of the perforated material, b) the clean-ability of the envelope's layers, c) the material's properties and its resistance to the climatic changes, d) the changeability of damaged parts/panels of the envelope, and e) the suitable technical and technological solutions those insure the durability of the perforation.

5.3. Guidelines development process

The development process of the extracted guidelines has been decided to be a sort of an evaluative questionnaire, which has been sent to different experts those have certain related experience to the topic, in order to get their evaluative feedbacks about the importance level of each guideline within the early design process of a perforated building's envelope. A main list of experts has been prepared including contacts of sixty experts, those have designed the sixty selected cases, in order to contact experts from different regions and to stay within the contexts of the selected cases those helped in extracting the guidelines (Table 5.1).

Expert no.	Location	Expert no.	Location	Expert no.	Location
1	New York, USA	21	Paris, France	41	Biot, France
2	Tokyo, Japan	22	New York, USA	42	Jaffa, Palestine
3	Beirut, Lebanon	23	Copenhagen, Denmark	43	Abu Dhabi, UAE
4	Barcelona, Spain	24	Wattana, Thailand	44	Santa Monica, USA
5	Helsinki	25	Paris, France	45	Rotterdam, Netherlands
6	Paris, France	26	Milan, Italy	46	Sao Paolo, Brazil
7	Seville, Spain	27	Minnesota, USA	47	Amsterdam, Netherlands
8	Zurich, Switzerland	28	Barcelona, Spain	48	Basel, Switzerland
9	Paris, France	29	Paris, France	49	Cape Town, South Africa
10	Warsaw, Poland	30	Paris, France	50	Singapore
11	Copenhagen, Denmark	31	Kanagawa, Japan	51	Negev, Palestine
12	Moscow, Russia	32	Rotterdam, Netherlands	52	Valencia, Spain
13	Köln, Germany	33	New Delhi, India	53	Jaffa, Palestine
14	Madrid, Spain	34	Wien, Austria	54	Barcelona, Spain
15	Copenhagen, Denmark	35	Safat, Kuwait	55	Jaffa, Palestine
16	Stockholm, Sweden	36	Berlin, Germany	56	Bangkhen-Thailand
17	Argentina	37	Seoul, Korea	57	Rome, Italy
18	Bandol, France	38	Dubai	58	Melbourne, Australia
19	Melbourne, Australia	39	Los Angeles, USA	59	Sydney, Australia
20	Wien, Austria	40	Paris, France	60	Tehran, Iran

Table 5.1: The main list of contacts including 60 global experts.

In order to facilitate the evaluation process and to increase the response rate, each expert has received (by email) only ten guidelines to evaluate them. For this reason, the guidelines have been divided sequentially into six groups.

While, in the case of getting very low response rate (less than the average 'email response rate', which is 40% according to Sheehan (2011)), an alternative list has been prepared including different researchers those have published some related scientific works. This alternative list included 20 researchers from different global institutions (Table 5.2). Similarly, in order to facilitate the evaluation process and to increase the response rate, each researcher has received (by email) only 15 guidelines to evaluate them. For this reason, the guidelines have been divided sequentially into four groups.

Researcher no.	Institution	Researcher no.	Institution
1	Polytechnic of Milan, Italy	11	ENEA, Rome-Italy
2	University of the Basque Country, Bilbao-Spain	12	University of the Basque Country, Bilbao-Spain
3	American University in Cairo, Egypt	13	Cairo University, Egypt
4	Ain Shams University, Cairo, Egypt	14	Ain Shams University, Cairo-Egypt
5	Lawrence Berkeley National Laboratory, USA	15	Technical University of Denmark
6	ENEA, Rome, Italy	16	Polytechnic of Milan, Italy
7	University of the Basque Country, Bilbao-Spain	17	University of the Basque Country, Bilbao-Spain
8	Energy Efficiency in Buildings Unit, Madrid-Spain	18	American University in Cairo, Egypt
9	Ain Shams University, Cairo-Egypt	19	Ohio State University, USA (LEED-accredited professional)
10	Syracuse University, NY-USA	20	Technical University of Denmark

Table 5.2: The alternative list of contacts including 20 global researchers.

5.3.1 Experts responses and feedbacks

The response rate of the main list of experts was only 6.7% (4 responses out of 60), which is very low. This was a significant reason to re-contact the researchers of the alternative list, but it also resulted in a very low response rate of only 15% (3 responses out of 20). Nevertheless, the seven responses included all the obtained grouping of the extracted guidelines, where each guideline has been evaluated by one or two experts.

More strong responses were expected from experts to evaluate the level of impact of the extracted guidelines, that the extracted guidelines would have been more objective and measurable. However, despite the low response rates, all of the contacted experts and researchers were in agreeing with the impact of each guideline, with different levels, in the design process of the perforated envelopes. None of the guidelines has been evaluated as having no impact on the design process, all feedbacks (Table 5.3) confirm the low, the significant, or the high impacts of the proposed guidelines, where nine guidelines were evaluated as having a low impact on the design process, while the other 51 guidelines were evaluated as having high or reasonable impacts on the design process of the perforated envelopes.

Accordingly, there are no strange responses to be mentioned. So, theses guidelines could be validated as a base point for architects and architecture students, to be developed in different ways and adopted in the future research and designs, in order to suit the different contexts and intentions.

Guideline code	*Guideline's impact on the perforated envelope's design*				Guideline code	*Guideline's impact on the perforated envelope's design*			
	High impact	Reasonable impact	Low impact	No impact		High impact	Reasonable impact	Low impact	No impact
G.TE.1					G.EN.31				
G.TE.2					G.EN.32				
G.TE.3					G.EN.33				
G.TE.4					G.EN.34				
G.TE.5					G.EN.35				
G.TE.6					G.EN.36				
G.TE.7					G.SC.37				
G.TE.8					G.SC.38				
G.TE.9					G.SC.39				
G.TE.10					G.SC.40				
G.TE.11					G.SC.41				
G.TE.12					G.SC.42				
G.TE.13					G.SC.43				
G.TE.14					G.SC.44				
G.TE.15					G.SC.45				
G.TE.16					G.SC.46				
G.TE.17					G.SC.47				
G.TE.18					G.EC.48				
G.EN.19					G.EC.49				
G.EN.20					G.EC.50				
G.EN.21					G.EC.51				
G.EN.22					G.EC.52				
G.EN.23					G.EC.53				
G.EN.24					G.EC.54				
G.EN.25					G.EC.55				
G.EN.26					G.EC.56				
G.EN.27					G.EC.57				
G.EN.28					G.EC.58				
G.EN.29					G.EC.59				
G.EN.30					G.EC.60				

Table 5.3: Feedbacks of experts in both of the main and the alternative lists. The light gray indicates one evaluation, and the dark gray indicates two similar evaluations.

CONCLUSION

Findings

It has become clear that the perforation strategies have strong historical roots, as they have been adopted for different purposes to maintain and produce sustainable traditional buildings and sustainable built environments after a successful integration between all of urban and architectural components. The chronological part of this study clearly shows a great change to the technological methods and the functional quality of the use of perforated envelopes in the contemporary architecture. This leap produced a formative change that is totally different from the past, and even different from the perforations those continued until the late twentieth century. A significant functional change also happened, which is related to the designers intentions towards using such design strategy and to the envelope's performance, whether by adding new functional positives or by losing old values and neglecting some of the currently desired needs. In addition, the impact of digital technology seems clear in this architectural trend in terms of appearance, manufacturing and implementation.

Reviewing the related literature showed that the related research is still limited, with a prime focus on the environmental aspects of the perforated sheets. Nowadays, there is a great deal of global interest in producing such type of building envelope which increases the need for a design base to guide this trend in the future which constitutes the main objective of this research with the assumption that there is a possibility to extract a number of holistic guidelines from the recently implemented perforated buildings considering the historical bases of this trend, which has been proven by the already obtained results.

The analysis of multi-cases of the contemporary perforated buildings showed certain indicators and dominant features that helped in extracting the guidelines. No doubt that these guidelines need to be appropriated in the future, for each context, to fit the spatial properties, the socio-cultural values, the socio-economic aspects, and the climatic variables, since this topic has a huge number of dimensions, indicators, and variables. This requires extended practical efforts and analytical works for outlining each contextual appropriateness criterion.

Dominant design features

From the multi-cases analysis (Chapter 4), a set of dominant design features has been extracted that reflect the architects' tendency to significantly employ them within their designs in the contemporary trend of perforation. Those features are presented in Table (1) by with the related guidelines, question, and design consideration or the significant future consideration towards each dominant design feature to be adopted in the future designs as it was elaborated in the guidelines extraction part (Chapter 5), as follows:

Dominant design feature	Level of presence	Related question	Related guideline	Design consideration
Perforation of the newly-built works.	88%	Q.1	G.TE.1	Perforation has significant potentials in refurbishing the previously built works, to enhance their performance.
Using either one perforated facade only, or using more than four perforated facades in the same building.	63%	Q.2	G.TE.2	Using one perforated facade was mainly for environmental purposes, while using more perforated facades can also provide an appearance accordance.
The use of fully perforated facades.	67%	Q.3	G.TE.3	Solids and voids should regard the needs within the internal spaces, in both of the partial and full perforations.
South-east and south-west orientation of perforated facades	51%	Q.4	G.TE.4	This confirms the environmental role of perforations, while both the azimuth and the altitude orientations should be considered.
Flat-shaped perforated facades with different 3D details for shaping the perforation.	77%	Q.5	G.TE.5	Other shapes can also play a significant role in gaining or rejecting the solar heat.
Using single perforated layer.	93%	Q.6	G.TE.6	Using more than one perforated layer can be thermally useful and

Dominant design feature	Level of presence	Related question	Related guideline	Design consideration
				it could increase the privacy levels, but it could be visually critical, especially when each layer has a different perforation sizing.
The absence of roof perforation.	85%	Q.7	G.TE.7	The inclined perforated facades can play some roles of the perforated roofs.
Using metals as perforation materials.	42%	Q.8	G.TE.8	The selection process of material is complex, but it should consider all of its characteristics and values.
The use of drilled perforated panels \ the prefabricated panels.	67%	Q.9	G.TE.9	An attention should be paid towards the economic dependency of manufacturing technologies.
The use of glass layer behind perforation in the double skin facades.	67%	Q.10	G.TE.10	Creating compatible envelope's contents technically, thermally, and structurally is important.
The use of primitive geometries of perforation pattern.	80%	Q.11	G.TE.11	Primitive geometries can be creatively used to provide contextualized architectural style and identity.
The use of tiny-sized perforations.	52%	Q.12	G.TE.12	The tiny perforations shouldn't negatively affect the daylight transmission, the amount of heat transfer, and the visual comfort.
Regular arrays for the configuration of perforations.	92%	Q.13	G.TE.13	The configuration of perforations should regard equally the functions of interior spaces without depriving them of their basic requirements.
Perforation ratio of 11-50%	87%	Q.14	G.TE.14	The considered ratio should regard the veiling-revealing ratios, shading percentage, visibility, and openness.
Using the double skin envelopes	62%	Q.16	G.TE.16	Double skins can create a positively significant thermal difference between inside and

Dominant design feature	Level of presence	Related question	Related guideline	Design consideration
				outside, if designed carefully.
Using static perforated layer.	78%	Q.17	G.TE.17	Dynamic perforated layer is crucial, whether it is manual or automatic, as it facilitates the production of adaptive facades.
The designers intention focuses on environmental and aesthetic purposes.	73%	Q.19	G.EN.19	Contributing to the achievement of sustainable buildings should also be a main intention in designing the perforated envelope.
The unintentional purpose of orientating perforated facades.	55%	Q.20	G.EN.20	Considering the environmental orientations of the facades should be intentional as it adds a value to the perforated envelope's function.
The adoption of facade's openness ratio of 11-35%.	57%	Q.21	G.EN.21	For a suitable daylight transmittance and visibility, the perforation and the openness parameters have mutual relationships those should be intentionally determined together.
Using common man-made building materials.	60%	Q.23	G.EN.23	The door for considering innovative materials remains open, but the costs and the architectural identity are still important.
Using perforated layers those have no insulations.	82%	Q.25	G.EN.25	The internally solid or vacant perforated layers can include different types of insulations.
The use of perforated layer of variant width\depth proportions.	32%	Q.27	G.EN.27	The proportion between the hole's size and the perforated layer's depth should be deliberately considered as it changes shading ratio, determines the possible birds nesting, dust accumulation and insects gathering.
The use of moderately moisture resistant materials.	82%	Q.28	G.EN.28	The selected material could be treated by different technologies

Dominant design feature	Level of presence	Related question	Related guideline	Design consideration
				to modify its resistance, without highly increasing the cost.
Controlling the heat transfer by the perforated envelope.	63%	Q.29	G.EN.29	The perforation sizing, perforation ratio, perforated layer's material and thickness, cavity depth, orientations, and insulation, should be considered altogether to enhance the envelope's thermal performance.
Not considering other passive design techniques.	77%	Q.30	G.EN.30	Perforation doesn't eliminate the use of other passive design strategies those can play a significant integrative role in maintaining a sustainable building.
Not considering energetically operational elements within the envelope.	92%	Q.32	G.EN.32	Clean energy can be considered and employed for operating the envelopes elements.
Considering the energy-saving.	62%	Q.33	G.EN.33	It is important to increase extent of energy saving to a desirable level by producing more thermally-efficient and functional perforated layers.
The need for technology to implement the perforated panels.	80%	Q.34	G.EN.34	The adopted technology should be environmentally acceptable and economically feasible
The absence of using some other active design strategies.	93%	Q.36	G.EN.36	The active design strategies have many possibilities those can be carefully included in the design of a perforated envelope.
Considering perforations with no signs of cultural symbolism.	80%	Q.37	G.SC.37	A great lesson can be learnt from the traditional models, especially the Mashrabiya which has a dominance interpretation in the contemporary architecture.
Obscuring the viewability by perforation sizing.	85%	Q.40	G.SC.40	The issue of viewability should be considered in the design process by avoiding the very tiny-sized perforations, when needed.

Dominant design feature	Level of presence	Related question	Related guideline	Design consideration
Obscuring the viewability by the perforation configuration.	85%	Q.42	G.SC.42	The perforations' configuration shouldn't be only as an aesthetic aspect, it also should be functional aspect regarding the viewability.
Increasing the privacy by perforation configuration.	95%	Q.43	G.SC.43	The perforations' configuration has a functional value of providing veiling and revealing at the same facade.
Increasing the acoustical comfort within the perforated layer.	68%	Q.44	G.SC.44	Noise absorption can be enhanced by different design parameters of the perforated envelope those should be carefully calculated.
Increasing the physical security.	90%	Q.46	G.SC.46	Using rigid, stable, and wind resistant perforated layers with suitable perforation sizing can produce a preferable type of a physically protective envelope.
Increasing the visual privacy.	93%	Q.47	G.SC.47	The envelope's perforation increases relatively the levels of visual and acoustical privacy to some extents.
Using perforated materials of high initial costs.	42%	Q.48	G.EC.48	Efforts to reduce the embodied energy and associated emissions through the substitution of bio-based products can reduce the emissions from buildings and even the cost.
The using of cost independent perforation techniques.	80%	Q.49	G.EC.49	Considering the low-cost techniques and technologies during both the production and the implementation processes to provide the preferred perforated panels can encourage people of different economic abilities to consider the perforation within their own houses.
Decreasing the overall running costs.	55%	Q.51	G.EC.51	The costs of perforated envelope's dynamism,

Dominant design feature	Level of presence	Related question	Related guideline	Design consideration
				maintenance, and repairs, should be determined to be less than the costs of saved energy.
Using locally available materials within the perforated layer.	95%	Q.53	G.EC.53	The locally available materials decrease the building's initial costs. While at the same time, possible low-cost modifications can be made for different types of materials to improve their properties to comply with the local climatic conditions.
Controlling the penetration of rainwater into the envelope	87%	Q.54	G.EC.54	To immediately get rid of the rainwater that penetrates into the air cavity through the perforated layer, the double-skin envelope should be dried quickly by diffusion and ventilation, or by using some suitable design techniques or strategies.
Considering dust accumulation inside perforations.	63%	Q.55	G.EC.55	Avoiding thick perforated layers with very tiny-sized perforations, or it can be prevented by some other technical design treatments.
Considering the birds nesting inside perforations.	70%	Q.56	G.EC.56	Avoiding thick perforated layers with perforation size that is suitable for birds, or it can be prevented by using some other technical design treatments.
The use of easily cleanable perforated layer.	78%	Q.58	G.EC.58	An importance should be given for finding, within the design process, some certain technical treatments for the perforations sizing, shapes, surfaces textures, layers thicknesses, material's types and properties, etc.
The use of easily cleanable air cavity sides, in the double skins.	57%	Q.59	G.EC.59	The envelope's layers should contain some moveable parts to easily clean them and repair the possible technical problems

Dominant design feature	Level of presence	Related question	Related guideline	Design consideration
				happen into the air cavity.
Considering maintainable and changeable perforated layers \ panels.	83%	Q.60	G.EC.60	Some aspects should be considered for achieving a maintainable perforated envelope: a) recyclable material, b) cleanable layers, c) reasonable material properties, d) changeability parts, e) suitable design solutions.

Table 1. The list of dominant design features of the contemporary perforated envelopes.

In order to make any spatial appropriateness of the extracted guidelines, there is a need for making a series of experimental works, numerical calculations, simulations, determining the initial cost-efficiency, periodic maintenance and operational costs, and adopting the considerable socio-cultural connectivity and community values, etc.

The added value within this research constitutes a starting point for interested architects and students of architecture to consider the extracted guidelines within the early phases of their related future designs.

Related independent developments

Different proposals and empirical works have been conducted separately as a part of developmental work. Those works include workshop's group work and scientific publications those highlight the appropriateness process and different potentials of the perforated envelopes in different contexts, including the following outputs:

a) An example of experimental work has considered the proposed guidelines to develop a design model of an adaptive perforated facade for an office building in a certain location of Sao Paolo city in Brazil (Fig. 1). This work has been proposed within a working group session in the training school of "Adaptive Facades" at Hafencity University- Hamburg, 2016. The design work was proposed by a group of six persons who came from different European universities, including the Ph.D. candidate who conducted this thesis, a research assistant in Buildings Physics from Delft University of Technology, a PhD candidate in "Architecture" from Politecnico di Torino, a PhD candidate in Buildings Physics from Libera Università di Bolzano, a PhD candidate in Architecture from Universidad Politecnica de Madrid, and a master's student in Engineering from Lund University.

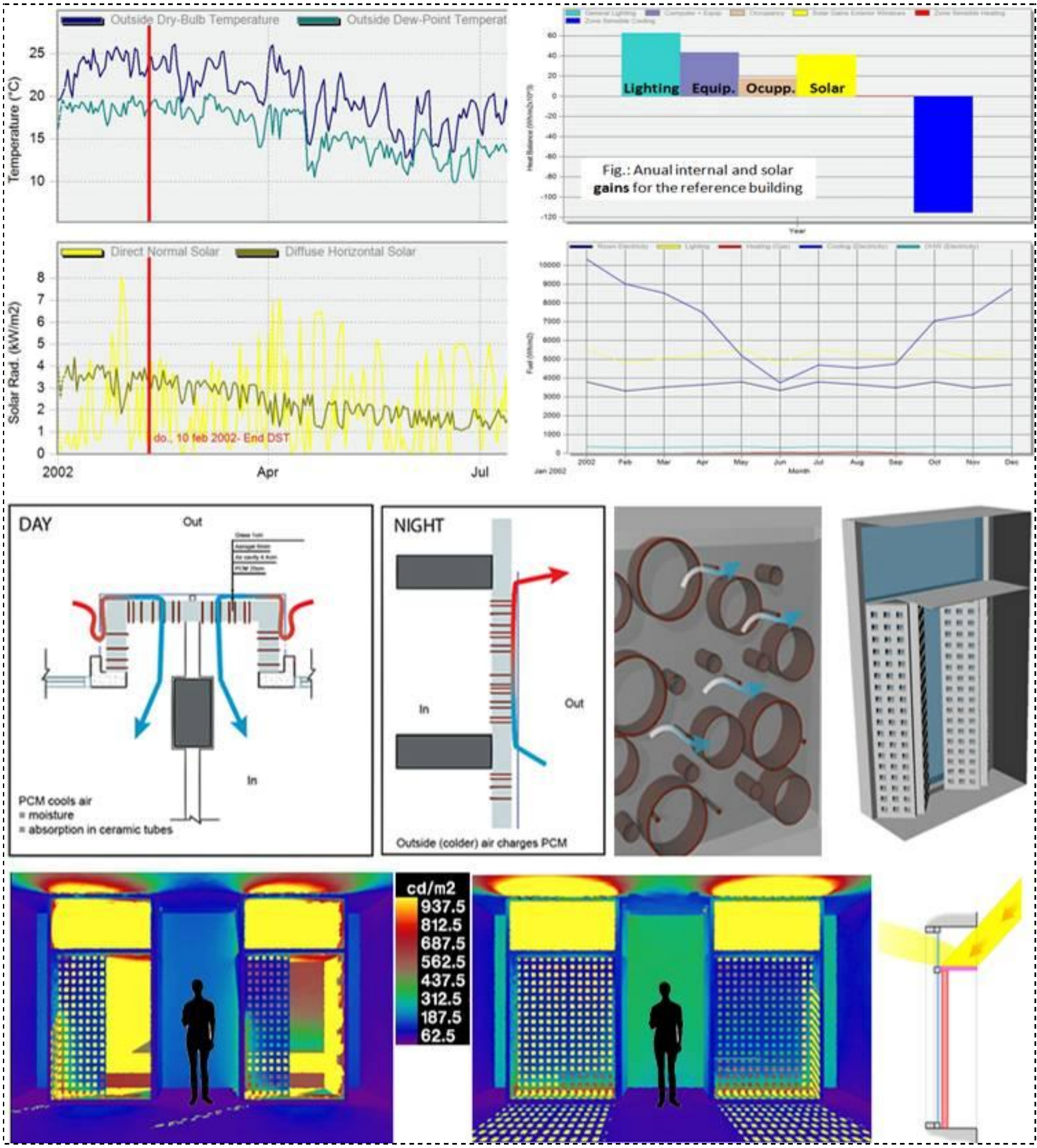

Figure 1: A proposed design model for a passively adaptive perforated facade of an office building in Sao Paolo-Brazil (Group work, design, and simulations).

The proposed design model (Fig. 1) has adopted the use of cheap ceramic cylinders to shape the perforations into a facade layer of phase change material (PCM) to act as a humidity-eating technique, where the condensed humidity can be used for irrigating the internally used plants.

The layer of perforated ceramic cylinders was followed by an external layer of selective glazing and an air cavity between them, where the cooling of the PCM for thermal and condensation purposes can be done by the enhancement of the cross ventilation process in an integration with proposed solar chimneys those are located in the central area of the building. In addition to this, the openable glazed parts of this passively adaptive facade included an implementation of the external layer of foldable perforated panels, in order to control the glare and solar radiation effects for enhancing the occupants' visual and thermal comforts. The foldable panels also contribute in decreasing the pollution by using a smog-eating perforated material (Thermoformed plastic +Tio2). This design took into consideration the cost-efficiency, contextual socio-cultural values, and the local technical and environmental parameters.

b) Separated scientific publications those highlight different challenges, potentials, and proposals for perforated envelopes in some certain contexts, as the following:

- Alatawneh and Germanà (2016), "Earth for social housing in Palestine: an alternative for a sustainable refurbishment of building's envelopes", which focuses on the possibility of using earth as an alternative material to refurbish the envelopes of existing residential buildings in Palestine, including two categories; firstly, refurbishing the envelopes of housing units those were partially destroyed during the attacks in Gaza. Secondly, refurbishing the envelopes of existing houses to fit the basic environmental considerations. Where, both categories respect the sustainability dimensions; the social contexts, economic levels of occupants, besides the attention towards the technical and environmental improvements of earth in the future. Where the proposals (Fig. 2) focus on using earthen perforated envelopes as an economic solution within the refurbishment works, to enhance the envelope's environmental and socio-cultural values by using the transitional social space between inside and outside.

- Germanà and Alatawneh (2016), "Reviving Earthen Architecture in Palestine: The added significances of the building sustainability and an opportunity for the future", which focuses on outlining the general advantages (social, environmental, and economic) and the limits of using earth as an alternative building material for refurbishing the buildings' envelopes in some regions of Palestine, in comparison with the current prevalent way of constructions, by highlighting the use of perforation in the new earthen buildings and discussing the different needs in the rural and in urban contexts, taking into account the housing emergency due to the successive military attacks there. This help in gaining a useful innovation for the future, in Palestine as well as in the most parts of the Mediterranean region.

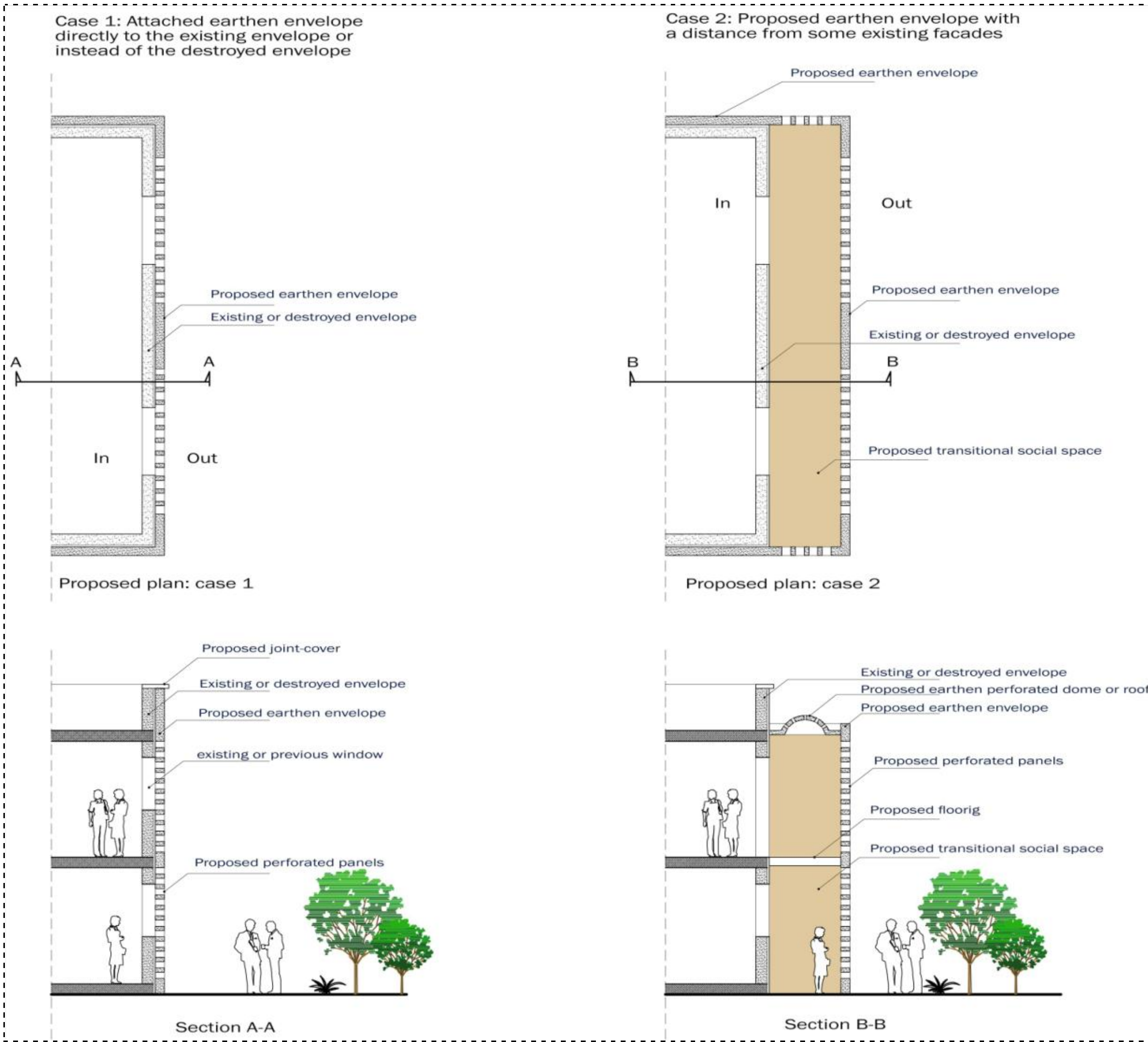

Figure 2: A proposed design model of the earthen perforated envelope for the building's refurbishment process in Gaza, Palestine (Alatawneh & Germanà, 2016).

- Germanà *et. al.* (2015), "Technological and behavioural aspects of perforated building envelope in the Mediterranean region", which discuss the appropriateness and potentials of advanced solutions of contemporary perforated envelopes in the Mediterranean region in order to outline an appropriate integration of technological and behavioural aspects those can be obtained in the future of the trend.

- Alatawneh *et. al.* (2015), "Near Zero Energy House in Palestine: Identification of the future challenges", which introduces the challenges of using energy-efficient buildings in Palestine as a base point to highlight the passive design strategies of earthen envelopes, which in turns highlighted the concept of perforation in the subsequent publications.

These proposals can be considered as examples for the subsequent developmental phases with the adoption and the appropriateness of the design guidelines to be applied to perforated envelopes in specific contexts.

Recommendations and future visions

Based on this research, different significant recommendations can be put under the attention of researchers, architects, and students those are interested in designing perforated envelopes in the future, as follows:

- The perforated envelopes have several environmental potentials and considerations those are not only limited to providing shades, reducing heat transfer, or reducing glare but also the other potentials should be also considered, as highlighted in this study.

- Considering the socio-cultural values is important, in all types of building's envelope, as it gives an identity to the building and strengthens its connectivity to the surrounding context, which is one of the architects' responsibility.

- The economic factor is changeable from community to community and from person to person, therefore, innovative solutions of buildings envelopes systems must highly consider this issue, where the innovative design solutions can't be only limited to the use of automotive, or smart envelopes of high initial or operational costs.

- The Mashrabiya has proven its environmental role among history until the present time, while the recent interpretations are mostly neglecting its socio-cultural role. Where, this socio-cultural role can be renewed and re-activated in different ways, even if the Mashrabiya becomes a globalized system, as each context has its own cultural attributes in different ways.

- Refurbishment of existing buildings in different regions, to fit the sustainability principles, is crucial. Therefore, the earthen perforated envelopes have the potential to be used in this setting, where perforation as a passive design strategy, has many environmental, cultural, and social values, so it could play a significant role in developing some concepts of refurbishing the buildings envelopes.

As a future vision, there is a need to formulate the design guidelines in different contexts such as the Mediterranean region, to introduce the design alternatives, and to provide specific recommendations to derive the design models of the future perforated envelopes in these contexts.

This study constitutes the basis for developing extended research in this field, as it introduces a conceptual comparison of the perforated envelopes among history, where some theories can be extracted and developed in the future research (i.e. the veil and the cage forms of perforation). However, an extended related work will be hopefully conducted in the near future.

In addition to the guidelines in a future stage of development, it would be reasonable to write the objective and measurable rules for the design of enclosures for different climatic regions, using data mining and simulation tools, date techniques, etc. there is a need for the drafting of Policy Standards or Codes of Practices in the future for the application of the results in the identified scenarios.

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APPENDICES

APPENDIX A

TESTS OF THE ANALYTICAL MODEL

A.1. The initial analysis sheet format (phases 1 & 2)

Technological components of the building's envelope		
Perforation data	**Construction data**	**Environmental issues**
No. of perforated faces of the envelope: 1 \ 2 \ 3 \ 4 \ More	Type of intervention of the perforation: Newly added \ Previously built	Perforated material resistance to moisture: Highly \Moderately\Slightly
Orientation of the perforated faces: (S \ N\ E \ W \ SE \SW\NE \NW) \ NA	Envelope faces shape: Flat \Deconstructed\ Organic\ Composite	Perforated material resistance to heat gain and heat loss: Highly\ Moderately\ Slightly
Status of roof perforation: Perforated \Not perforated	Type of perforated material: Glass\ Concrete\ Stone\ Metal\ Earth\ Wood\ Terracotta \ Composite	Using insulations within envelope: Used\ Not used \NA
No. of inclined perforated faces: 0\ 1\2\3\4\ More	Type of material behind the perforation: Glass\ Concrete\ Stone\ Metal\ Earth\ Wood\ Composite	Drainage of rain penetrated behind perforations: Considered\ Not considered \ NA
No. of perforated layers: 0\ 1\2\ More	Approx. thickness of perforated material: 1- 10mm\ 2-5cm\5-30cm\ Over 30 cm	Natural ventilation method: Manually\ Mechanically \ Smart \ NA
Perforation pattern shape: Geometric\ Floral \ Symbolic\ Organic \Composite	Approx. depth between the perforated material and the main external wall: 0 \1-50 cm \ 0.5- 1m \ more than 1 m	Using smart envelopes: Used \ Not used\ NA
Approx. perforation ratio in each face: 1-10% \ 10-35% \35-50% \ Over 50%	The perforated material is common in the local context: Yes \ No \ Sometimes	Using renewable energy systems within the envelope: Used \ Not used\ NA
Perforation pattern geometry is common in the local context? Yes \No \Sometimes	Lightness of the perforated material: Light \ Slightly heavy \ Heavy	Percent of natural light transmission to inside: 1-10% \ 10-35% \35-50% \ Over 50%
Concept of perforation: Aesthetic\ Identity \Environmental\ Else	Existence of windows beside perforation: Existed \ Not existed\ Few existence	Seasonal changes of envelope elements: No change\ Changeable
Preventing birds roosting method: Considered\ Not considered\ NA		Respecting the nature: Highly \ Moderately\ No respect\ NA
Socio-cultural components of the perforated envelope		
Usability of envelope	**Adaptability with design**	**Connectivity to context**
Main users of building (age & gender): Children\ Youth\ Old\ All Males \ Females\ Both	Physical security of envelope: Secure \ Not secure\ NA	Pattern relation to the local culture and identity: Related \ Not related \ Neutral\ NA
Users physical relation to the perforation: Reachable \ Not reachable\ NA	Psychological security of envelope: Secure \ Not secure\ NA	Occupants ability to contact adjacent buildings visually: Able \ Slightly able\ No ability \ NA
Seeing outside status: Easy\ Difficult \ Blocked view	Privacy on the visual level: Gained \ Slightly gained \ Not gained\ NA	Ability to contact occupants of neighbouring buildings verbally: Able \ No ability \ NA
Envelope windows are openable by users: Yes \ No \ NA (no windows)	Privacy on the acoustical level: Gained \Slightly gained\ Not gained\ NA	Ability to contact the passing pedestrians visually: Able \ Slightly able\ No ability \ NA
Users ability to go between the main wall and the perforated envelope if a space is existing: Able \ No ability \ NA	Feeling of closure: High \Moderate\Slight \ NA	Ability to contact the passing pedestrians verbally: Able \ No ability \ NA
Economic components of the perforated envelope		
Construction costs	**Running costs**	**Maintainability**
Perforated material costs: High\Moderate \ Low\ NA	The envelope was designed to reduce heating and cooling costs: Yes \ No	The envelope perforated material is recyclable: Yes \ No

Perforated envelope technology costs: High\ Moderate\ Low\ NA	The envelope was designed to control artificial lighting costs: Yes \ No	The perforated material is cleanable: Easily \ Hardly \ Not cleanable
Residents self-constructed envelope: Yes \No	The envelope has self-energy production components: Yes \ No	The main envelope is cleanable: Easily \ Hardly \ Not cleanable
Using local resources: Yes \ No	The technological operation of envelope is expensive: Yes \ No \ Not used	The envelope material resists the climatic changes: Highly \ Moderately \ Slightly
The controlling technology used for envelope is cheap: Yes \ No \ Not used		The envelope components can be maintained: Yes\ No

A.2. Testing the final analysis sheet (phase 3)

The covering letter format (it was sent to the selected analysts, accompanied by the pre-final analysis sheet):

"This document includes an analytical model which has been proposed by the researcher to analyze the buildings' perforated envelopes. The need here is to test the model before applying it to multi-selected cases. The test includes one randomly-chosen case which should be analyzed by different qualified persons. As a case analyst, your analysis will be used for academic and research purposes only, so please be aware of your answers fidelity as they will affect the validation process and the research results".

Answering process:

- For data gathering, you can use the provided links and other links, Google maps, and Google images, etc.
- Please fill the boxes of the appropriate answers by using the "fill" tool in MS word, and use a gray colour.
- Leave answers those need calculations or those you can't answer without fill.
- You can write down any helpful notes, and reasons for not answering a certain question/s, by the end of this document.
- The answers guide is written after the sheet form which explains each question answering criteria.

<u>Note:</u> all materials, contents, concepts, data, tables, information included in this document are copyrighted for the researcher only, and any use of them should be referenced to this work.

A.3. The filled analysis sheet (filled by different analysts, to be tested)

Filled sheet (1)									
Analyst institution:	University of Minho, Portugal								
Analyst qualification:	Ph.D. candidate (Curriculum of Sustainable Architecture)								
Technological data of the perforated envelope									
Construction & perforation parameters									
Question		**Answer options**							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces				
Environmental indicators of the perforated envelope									
Passive design parameters									
Question		**Answer options**							
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others			
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others			
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios			
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No					
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant			
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA				
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA				
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA				
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others		
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA				
Q.29	Does the perforated layer decrease heat transfer when needed?	Yes: brise soleil	No	Slightly	NA				
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No	NA					

Active design parameters							
Question		**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: Agha Khan Award	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern have a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there are no openable elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In the case of double-skin, does the air cavity impede or obscure occupants' viewability to the outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In the case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No		
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial cost?	High	Moderate	Low	NA		
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Does the perforation decrease building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No				
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Analyst notes: no notes.

Filled sheet (2)

Analyst institution:	University of Palermo, Italy
Analyst qualification:	Ph.D. candidate (Curriculum of Architectural Design, Theory & Technology)

Technological data of the perforated envelope

Construction & perforation parameters

Question		Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces				

Environmental indicators of the perforated envelope

Passive design parameters

Question		Answer options					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer decrease heat transfer when needed?	Yes: changeable perforation sizing	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: Specify	No	NA			

Active design parameters

Question		Answer options				
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA		

Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels		No: manually created			Others
Q.35	Does the building have some awards/certificates?	Yes: Aga Khan Award for Architecture			No	NA	
Q.36	Are there other used active design techniques/elements?	Yes: perforated façade is controlled electronically from a photovoltaic sensor which permits 10% to 30% daylight.				No	NA
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern have a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials		NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades		NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades		No	NA
Q.41	In the case of double-skin, does the air cavity impede or obscure occupants' view-ability to the outside?	Yes	Slightly	Not in all facades		No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades		No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades		No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades		No	
Q.45	In the case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades		No	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades		No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades		No	
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial cost?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Does the perforation decrease building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No				
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Analyst notes: Q.6: the façade is with one layer, that consists 27,000 diaphragms, organized in 113 panels <Cfr.https://yimingsu.files.wordpress.com/2010/12/arab-institute-jean-nouvel.pdf>. Q.35: answer is gotten from <https://en.wikipedia.org/wiki/Arab_World_Institute>.

Filled sheet (3)	
Analyst institution:	University of Palermo, Italy
Analyst qualification:	Ph.D. candidate (Curriculum of Architectural Design, Theory & Technology)

Technological data of the perforated envelope

Construction & perforation parameters

	Question	Answer options						
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built					
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More		
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None	
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others
Q.6	What is the number of perforated layers in the envelope?	1	2	More				
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated		
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels					
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others		
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant			
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays					
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant		
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant		
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA		
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces			
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces			

Environmental indicators of the perforated envelope

Passive design parameters

	Question	Answer options					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer decrease heat transfer when needed?	Yes: brise soleil	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				

Active design parameters

	Question	Answer options				
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA		

Q.33	Does the envelope's design enhance the energy-saving?	Yes	**Slightly**	No	NA		
Q.34	Does the perforation need technology for manufacturing?	**Yes: prefabricated panels**		No: manually created			Others
Q.35	Does the building have some awards/certificates?	**Yes: Agha Khan**			No	NA	
Q.36	Are there other used active design techniques/elements?	Yes: specify			No	**NA**	
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern have a cultural symbolism?	**Yes**	No	NA			
Q.38	Is the perforated material commonly used by the community?	**Yes**	No	Not all used materials		NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades		**NA**	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	**Yes**	Slightly	Not in all facades		No	NA
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades		No	**NA**
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	**Yes**	Slightly	Not in all facades		No	
Q.43	Does the perforation's configuration increase visual privacy?	**Yes**	Slightly	Not in all facades		No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	**Slightly**	Not in all facades		No	
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades		No	
Q.46	Does the perforation increase the physical security?	**Yes**	Slightly	Not in all facades		No	
Q.47	Does the perforation increase the occupants' visual privacy?	**Yes**	Slightly	Not in all facades		No	
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial cost?	**High**	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	**Yes**	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	**Yes**	No	NA			
Q.51	Does the perforation decrease building's running costs?	Yes	**Slightly**	No	NA		
Q.52	Is the perforated material considered durable?	**Yes**	Slightly	No	NA		
Q.53	Is the perforated material locally available?	**Yes**	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope design?	**Yes**	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	**NA**		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	**NA**		
Q.57	Is the perforated material recyclable?	**Yes**	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	**No**				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	**No**				
Q.60	Are the perforated panels easily maintainable/changeable?	**Yes**	No				

Analyst notes: Q.29: as a brise soleil, it can change its size depending on the sunlight angle, Q.35: the building has received the "Aga Khan Award for Architecture".

Filled sheet (4)	
Analyst institution:	Polytechnic University of Valencia, Spain
Analyst qualification:	Ph.D. candidate (Department of Architecture)

Technological data of the perforated envelope

Construction & perforation parameters

	Question	Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces				

Environmental indicators of the perforated envelope

Passive design parameters

	Question	Answer options					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Variant
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer decrease heat transfer when needed?	Yes: open & close	No	Slightly	NA		
Q.30	Are there other used passive design techniques /elements?	Yes: specify	No	NA			

Active design parameters

	Question	Answer options				
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA		

Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels		No: manually created			Others
Q.35	Does the building have some awards/certificates?	Yes: Aga Khan Award			No	NA	
Q.36	Are there other used active design techniques/elements?	Yes				No	NA
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern have a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials		NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades		NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades		No	NA
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades		No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades		No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades		No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades		No	
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades		No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades		No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades		No	
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial cost?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Does the perforation decrease building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No				
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				
Analyst notes: no notes.							

Filled sheet (5)

Analyst:	The researcher
Institution:	University of Palermo, Italy
Qualification:	Ph.D. candidate (Curriculum of Architectural Design, Theory & Technology)

Technological data of the perforated envelope

Construction & perforation parameters

Question		Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope

Passive design parameters

Question		Answer options					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Variant
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer decrease heat transfer when needed?	Yes: changeable perforation sizing	No	Slightly	NA		
Q.30	Are there other used passive design techniques /elements?	Yes: specify	No	NA			

Active design parameters

Question		Answer options				
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA		

Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels		No: manually created			Others
Q.35	Does the building have some awards/certificates?	Yes: Aga Khan Award			No	NA	
Q.36	Are there other used active design techniques/elements?	Yes: perforated façade is controlled electronically by photovoltaic sensors.				No	NA
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern have a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials		NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades		NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades		No	NA
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades		No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades		No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades		No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades		No	
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades		No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades		No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades		No	
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial cost?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Does the perforation decrease building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No				
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				
Analyst notes: no notes.							

APPENDIX B

MULTI-CASES DESCRIPTION AND ANALYSIS

All cases are described and analyzed as follows:

Case 1: Ornans Infant School

Structured information					
Building location:	Doubs-France	Architect/s:	Designer/Institution	Site topography:	Flat Land
Construction date/s:	2014-2015	Site context:	Suburban	Climatic zone:	Moderate climate
Building use:	Public /Residential	Users group:	Both genders- children	Floors number:	2 Floors

Visual information	Textual information
	The architects were looking for a way to use very thin mesh work forms on a façade mostly made of aluminium frame picture windows, they wanted to play on the decorative effect of a thin skin of panels on the facade, interspersed with a multitude of leaf-shape inlays and perforations. Seven different forms and up to 100 inlays for the densest panels, the inlaid panels create light and shade effects in the classrooms. Technically, the designers considered a thin glass-cement composite panel solution. But these panels would have required the use of peripheral stiffeners, which would lend little to the aesthetic result and increase the weight of the elements. They proposed pieces only 3 cm thick without surrounding supports.
Ref: <http://www.archiexpo.com/prod/lafarge/product-70029-968114.html>, (02/2015).	*Ref: <http://www.archiexpo.com/prod/lafarge/product-70029-968114.html>, (02/2015).*

Technological data of the perforated envelope

Construction & perforation parameters

	Question	Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass + Cement		
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			

Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant	
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays			
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces	
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA
Environmental indicators of the perforated envelope						
Passive design parameters						
Question		**Answer options**				
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No		
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA	
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA	
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA	
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA	
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA	
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No			
Active design parameters						
Question		**Answer options**				
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA		
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA	
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others		
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA		
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA		
Socio-cultural indicators of the perforated envelope						
Usability, adaptability, and connectivity						
Question		**Answer options**				
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA		
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No	

Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No	
Economic indicators of the perforated envelope						
Initial costs, running costs, and maintainability						
Question		**Answer options**				
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA
Q.49	Does the perforation technique have independent costs?	Yes	No	NA		
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA		
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA	
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA	
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA	
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA	
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA	
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA	
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA	
Q.58	Is the perforated layer easily cleanable?	Yes	No			
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA		
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No			

Case 2: Umimirai Library

Structured information					
Building location:	Kanazawa-Japan	Architect/s:	Coelacanth K&H	Site topography:	Flat Land
Construction date/s:	2011	Site context:	Urban	Climatic zone:	Moderate climate
Building use:	Public /Educational	Users group:	All genders-All ages	Floors number:	4 Floors

Visual information

Ref:<https://www.flickr.com/photos/eager/11366771053/in/photostream/>, (02/2015).

Textual information

The library project is a simple space measuring 45m by 45m with a height of about 12m, enclosed by a perforated wall. This massive volume served as a reading space in keeping with the mood and setting of a library. The concept was to design a certain atmosphere for books and reading areas. The building consists of a single quiet and tranquil room that resembles a forest, filled with soft light and a feeling of openness reminiscent of the outdoors, the building represents a continuous relationship that brings books and humans together. The large external perforated wall in the cavernous reading room features some 6,000 small openings (200, 250, and 300mm) across its entire surface that allow a soft, uniform light to enter the building, in addition to the burden of seismic force from any earthquakes is born across the entire expanse of this wall. A floor heating system that warms and cools the building under the floor has been installed in order to make this large space comfortable to inhabit, while large natural ventilation openings in the roof ensure a pleasant and comfortable indoor environment during the warmer months.

Ref: <http://www.arcspace.com/features/coelacanth-kh-architects/kanazawa-umimirai-library/>, (02/2015).

Technological data of the perforated envelope								
Construction & perforation parameters								
Question		**Answer options**						
Q.1	What is the type of intervention of the perforated envelope?	Newly added		Previously built				
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More		

Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None	
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others
Q.6	What is the number of perforated layers in the envelope?	1	2	More				
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated		
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels					
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	NA
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others		
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant			
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays					
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant		
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant		
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA		
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces			
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA		
Environmental indicators of the perforated envelope								
Passive design parameters								
Question		**Answer options**						
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others		
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others		
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios		
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No				
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant		
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA			
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA			
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA			
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others	
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA			
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA			
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No					
Active design parameters								
Question		**Answer options**						
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA		
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA				
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA			
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others				
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA				
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA				
Socio-cultural indicators of the perforated envelope								
Usability, adaptability, and connectivity								
Question		**Answer options**						
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA				
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA			

Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 3: Saint Joseph University

Structured information					
Building location:	Beirut-Lebanon	Architect/s:	Y. Tohme & 109 Architects	Site topography:	Mountainous
Construction date/s:	2011	Site context:	Urban	Climatic zone:	Moderate climate
Building use:	Public /Educational	Users group:	All Genders-Youth/Old	Floors number:	9-10 Floors

Visual information

Ref: <http://www.archdaily.com/192785/usj-campus-de-l%E2%80%99innovation-et-du-sport-109-architects-with-youssef-

Textual information

The new campus of SJU takes a contextual approach, integrating physically, culturally, and historically with Beirut's urban tissue. Conceptually an urban block with sculpted voids, the building's hollow spaces define six autonomous blocks and construct multiple viewpoints across Beirut, connecting students to their dynamic setting, the voids also generate a street-level meeting space, which flows fluidly to the top floor in the form of a massive staircase, it concludes at a landscaped terrace overlooking the city. Light is a vital element in oriental architecture and one that shapes its style and identity; the campus exposes alternate light qualities through "Mashrabiya" inspired perforations and a polycarbonate volume, such manipulation presents a striking contrast in filtered light and luminescence, a stylized random-opening treatment is a snapshot of the Lebanese War, lending a poetic glimpse into the reality of destruction and violence.

Ref: <http://www.archdaily.com/192785/usj-campus-de-l%E2%80%99innovation-et-du-sport-109-architects-with-youssef-

tohme/>, (04/2015).					*tohme/>, (04/2015).*				
Technological data of the perforated envelope									
Construction & perforation parameters									
Question		**Answer options**							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			
Environmental indicators of the perforated envelope									
Passive design parameters									
Question		**Answer options**							
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others			
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others			
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios			
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No					
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant			
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA				
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA				
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA				
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Variant		
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA				
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA				
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No						
Active design parameters									
Question		**Answer options**							
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA			
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA					
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA				
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others					
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA					

Q.36	Are there other used active design techniques/elements?	Yes: specify		No	NA	
Socio-cultural indicators of the perforated envelope						
Usability, adaptability, and connectivity						
Question		**Answer options**				
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA		
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No	
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No	
Economic indicators of the perforated envelope						
Initial costs, running costs, and maintainability						
Question		**Answer options**				
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA
Q.49	Does the perforation technique have independent costs?	Yes	No	NA		
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA		
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA	
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA	
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA	
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA	
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA	
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA	
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA	
Q.58	Is the perforated layer easily cleanable?	Yes	No			
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA		
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No			

Case 4: School Extension, Ganduxer

Structured information

Building location:	Barcelona-Spain	Architect/s:	Pich-Aguilera	Site topography:	Flat Land
Construction date/s:	2013	Site context:	Urban	Climatic zone:	Moderate climate
Building use:	Public /Educational	Users group:	All Genders-Children	Floors number:	6 Floors

Visual information

Ref: <http://www.archello.com/en/project/school-extension-quot-teresianas-ganduxer-quot>, (04/2015).

Textual information

The new extension relocates all grades and provides the school with new covered sports space with the necessary infrastructure to provide a service to the school and extracurricular activities. It has been a challenge to design a new building in an environment with the uniqueness and significance of the current Teresianas School. It was decided to locate the project in the best place of the plot that would not affect the visibility of the pavilion designed by Antoni Gaudí. The volume respects the height and distance of the surrounding buildings and links to the existing sports hall. The building had to talk about its time without turning its back to the specific textures of the existing buildings, so it was decided to use a woven ceramic facade that provided a large lattice facing the street and light and lighting elements into school, this double skin, allows more freedom and flexibility in the distribution of windows and opaque elements needed. The pavilion needed to provide a sports space on a basement floor, consequently, it was proposed a hanging metal structure that allowed the building a clear floor. The classrooms are distributed from a central hall that receives light in each of the floors, through a solar chimney. The whole project has worked to achieve minimum consumption of air conditioning and indoor air renovation, vegetation plays an important role in air quality and cooperates with the machinery necessary to reduce pollution. Radiating heating has been chosen as the solution that provides greater comfort and heat transfer.

Ref: <http://www.archello.com/en/project/school-extension-quot-teresianas-ganduxer-quot>, (04/2015).

Technological data of the perforated envelope

Construction & perforation parameters

	Question	Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Ceramic		
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope							
Passive design parameters							
Question		**Answer options**					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	10:1
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				
Active design parameters							
Question		**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In the case of double-skin, does the air cavity impede or obscure occupants' view-ability to the outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In the case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What are the perforated material's relative initial costs?	High	Moderate	Low	NA		
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			

Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 5: School in Cambodia

Structured information

Building location:	Sra Pou-Cambodia	Architect/s:	Rudanko & Kankkunen	Site topography:	Flat Land
Construction date/s:	2010-2011	Site context:	Rural	Climatic zone:	Tropical
Building use:	Public /Educational	Users group:	All Genders-Children	Floors number:	2 Floors

Visual information	Textual information
	The school is like a training center to encourage and teach poor families to earn their own living. The Sra Pou community is one of the unprivileged communities in Cambodia, who have been evicted from their homes in the city to the surrounding countryside. They lack basic infrastructure, decent built environment, and secure income. The new vocational school provides professional training and helps the people to start sustainable businesses together. It is also a place for public gathering and democratic decision-making for the whole community.
Ref: <http://ekuaziones.blogspot.it/2012_03_01_archive.html>, (06/2015).	*Ref: <http://ekuaziones.blogspot.it/2012_03_01_archive.html>, (06/2015).*

Technological data of the perforated envelope

Construction & perforation parameters

Question		Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Reeds	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	NA	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			

Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA	
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces		
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA	
Environmental indicators of the perforated envelope							
Passive design parameters							
Question		**Answer options**					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				
Active design parameters							
Question		**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In the case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		

Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What are the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 6: Institute Du Monde Arab (Institute of the Arab World)

Structured information

Building location:	Paris-France	Architect/s:	Jean Nouvel & Arch. Studio	Site topography:	Flat Land
Construction date/s:	1981-1987	Site context:	Urban	Climatic zone:	Moderate climate
Building use:	Public / Cultural	Users group:	All genders-All ages	Floors number:	11Floors

Visual information

Ref:<https://unamaquinalectoradecontexto.files.wordpress.com/2011/09/arab-world.jpg>, (06/2015).

Textual information

The Institute of the Arab World was originated in 1980 when 18 Arab countries concluded an agreement with France to establish an institute whose purpose was to spread knowledge of Arab World's language and culture and in order to be better known and understood in the West. The institute is primarily a building whose beauty is well recognized: both exterior due to the presence of its 240 'Mashrabiyya', and interior due to its quality in the library and exhibitions. The façade bordering the Seine follows the curve of the river while the South façade features a monumental rectangular glass-clad curtain wall. Inside the building, there are a museum, a library, an auditorium, a bookshop, and offices. The main feature and innovative element of the IMA are the advanced responsive metallic 'brisesoleil' on the south façade. Nouvel's proposal for this system was well received for its originality and its reinforcement of an archetypal element of Arabic architecture, the 'Mashrabiya'. He drew inspiration from the traditional lattice work that has been used for centuries in the Middle East to protect the occupants from the sun and provide privacy. The system incorporates several hundred light sensitive diaphragms that regulate the amount of light that is allowed to enter the building. During the various phases of the lens, a shifting geometric pattern is formed and showcased as both light and void. Squares, circles, and octagonal shapes are produced in a fluid motion as light is modulated in parallel. Interior spaces are dramatically modified, along with the exterior appearance.

Ref: <http://www.archdaily.com/162101/ad-classics-institut-du-monde-arabe-jean-nouvel/>, (02/2015).

Technological data of the perforated envelope									
Construction & perforation parameters									
Question		**Answer options**							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope							
Passive design parameters							
Question		**Answer options**					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Variant
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer decrease heat transfer when needed?	Yes: changeable perforation sizing	No	Slightly	NA		
Q.30	Are there other used passive design techniques /elements?	Yes: specify	No	NA			

Active design parameters						
Question		**Answer options**				
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA		
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA	
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others		
Q.35	Does the building have some awards/certificates?	Yes: Aga Khan Award	No	NA		

Q.36	Are there other used active design techniques/elements?	Yes: perforated façade is controlled electronically by photovoltaic sensors.				No	NA
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern have a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials		NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades		NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there are no open-able elements?	Yes	Slightly	Not in all facades		No	NA
Q.41	In the case of double-skin, does the air cavity impede or obscure occupants' view-ability to the outside?	Yes	Slightly	Not in all facades		No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades		No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades		No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades		No	
Q.45	In the case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades		No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades		No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades		No	
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial cost?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Does the perforation decrease building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No				
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 7: Seville Ceramics Museum

Structured information

Building location:	Seville-Spain	Architect/s:	AF6 Arquitectos	Site topography:	Flat Land
Construction date/s:	2009-2012	Site context:	Urban	Climatic zone:	Moderate climate
Building use:	Public / Cultural	Users group:	All genders-All ages	Floors number:	3-4 Floors

Visual information	Textual information

Ref: <http://www.detail-online.com/architecture/topics/hidden-ornamentation-ceramics-museum-in-seville-024076.html>, (01/2015).

In the inner courtyard of the museum, a new extension nestles gently against the borders of the existing plot and forms a modern exhibition floor. Above all, the Centre of Ceramic asserts itself by means of its facade decorations: a superimposed steel grid filled with ceramic sleeves of various sizes encases the new space. The suspended steel grid with its ceramic sleeves serves primarily as shelter from the sun. The sleeves have been stacked closer together on the exterior walls of the south-facing rooms. In shadier places, they allow both a view out and let in as much daylight as possible. It is not only the color of the sleeves that gives a concordant look to the façade's extension. This type of sunshade is reminiscent of the local decorative wood lattices, adopted originally from Arab culture and known as "Mashrabiyya". These screens help keep interior spaces cool and prevent unwanted glances from outside, but visitors can easily see out. The suspended façade, in some places, is purely decorative and is not meant to offer shelter from the sun. All the same, it provides a thematic reference to the history of the old factory.

Ref: <http://www.detail-online.com/architecture/topics/hidden-ornamentation-ceramics-museum-in-seville-024076.html>, (01/2015).

Technological data of the perforated envelope

Construction & perforation parameters

	Question	Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Steel + Ceramic		
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope							
Passive design parameters							
Question		**Answer options**					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: filled by ceramic	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Variant
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				

Active design parameters							
Question		**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			

Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there are no openable elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In the case of double-skin, does the air cavity impede or obscure occupants' view-ability to the outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In the case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		

Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What are the perforated material's relative initial costs?	High	Moderate	Low	NA		
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			

Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 8: Rapperswil-Jona Municipal Museum

Structured information

Building location:	Zurich-Switzerland	Architect/s:	Biel/Bienne, Mlzd	Site topography:	Flat Land
Construction date/s:	2007	Site context:	Suburban	Climatic zone:	Moderate climate
Building use:	Public / Cultural	Users group:	All genders-All ages	Floors number:	3 Floors

Visual information

Ref: http://www.a10.eu/materials/fresh_transition.html>, (02/2015).

Textual information

A fortified tower and connected residential building, constructed in the late 13th century, comprise part of the present complex, together with lavish 16th-century interiors that had been preserved and formed the origin of the museum. The project was to renovate and extend the local museum established in 1943, through competition in 2007 by Biel/Bienne-based MLZD architects. It is most remarkable for the outward appearance of the new extension – a polished brass form tactfully integrated into the existing historic image of narrow streets and medieval stone. The project immediately catches the eye with its spaceship-like perforated metal insertion (actually 0.5-mm-thick layers of brass applied onto both surfaces of a polyethylene core), which accents its immediate surroundings and is easily readable as the main entrance to the museum. The shape of the new building, springing as it does from the facades of the older structures, takes care not to intersect existing doors and windows, resulting in fascinating, angular interiors. There, light coming through the roof and internal illumination schemes present a sharp contrast to the older buildings, marking it as a fresh transitional space.

Ref: < http://www.a10.eu/materials/fresh_transition.html>, (02/2015).

Technological data of the perforated envelope

Construction & perforation parameters

Question		Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added		Previously built					
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Metal + Polyethylene			
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	NA	

Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others	
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant		
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays				
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant	
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant	
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA	
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces		
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA	
Environmental indicators of the perforated envelope							
Passive design parameters							
	Question	**Answer options**					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: waterproof	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				
Active design parameters							
	Question	**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
	Question	**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		

Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No	
Economic indicators of the perforated envelope						
Initial costs, running costs, and maintainability						
Question		**Answer options**				
Q.48	What are the perforated material's relative initial costs?	High	Moderate		Low	NA
Q.49	Does the perforation technique have independent costs?	Yes	No	NA		
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA		
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA	
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA	
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA	
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA	
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA	
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA	
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA	
Q.58	Is the perforated layer easily cleanable?	Yes	No			
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA		
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No			

Case 9: Lille Metropole Modern Art Museum

Structured information					
Building location:	Lille-France	Architect/s:	Manuelle Gautrand	Site topography:	Flat Land
Construction date/s:	2010	Site context:	Suburban	Climatic zone:	Moderate climate
Building use:	Public / Cultural	Users group:	All genders-All ages	Floors number:	2 Floors

Visual information

Ref: <http://www.e-architect.co.uk/france/lille-metropole-museum>, (01/2015).

Textual information

The museum is dedicated to contemporary and modern art and houses also one of the most beautiful collections of outsider art in Europe in the new extension. The architecture of the extension wraps around the north and east sides of the existing arrangement in a fan-splay of long, fluid and organic volumes. On one side, the fan ribs stretch in close folds to shelter a café-restaurant that opens to the central patio; on the other, the ribs are more widely spaced to form the five galleries for the Art brut collection. The Art brut galleries maintain a strong link with the surrounding scenery, but they are also purpose-designed to suit the works that they house: atypical pieces, powerful works that the one can't just glance at in passing. The folds in these galleries make the space less rigid and more organic so that visitors discover artworks in a gradual movement. The architecture is partly introverted, to protect artworks that are often fragile and that demand toned down half-light. At the extremity of the folds, a large bay opens magnificent views onto the surrounding parkland, adding breathing space to the visit itinerary. These views compensate the half-light in the galleries: the openwork screens in front of the bays mediate with strong light and parkland scenery, a feature that recalls Simounet's generous arrangements in the galleries that he designed. Envelopes are sober: smooth untreated concrete, with moldings and openwork screens to protect the bays from too much daylight. The surface concrete has a slight color tint that varies according to the intensity of light.

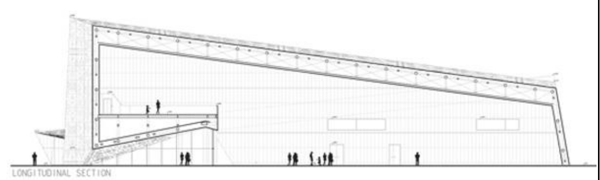
Ref: <http://www.e-architect.co.uk/france/lille-metropole-museum>, (01/2015).

Technological data of the perforated envelope									
Construction & perforation parameters									
Question		**Answer options**							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	organic				
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			
Environmental indicators of the perforated envelope									
Passive design parameters									
Question		**Answer options**							
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others			
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others			
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios			
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No					
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant			
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA				
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA				
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA				
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Variant		
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA				
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA				
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No						
Active design parameters									
Question		**Answer options**							
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA			
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA					
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA				
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others					
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA					

Q.36	Are there other used active design techniques/elements?	Yes: specify			No	NA	
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials		NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades		NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there are no open-able elements?	Yes	Slightly	Not in all facades		No	NA
Q.41	In the case of double-skin, does the air cavity impede or obscure occupants' view-ability to the outside?	Yes	Slightly	Not in all facades		No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades		No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades		No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades		No	
Q.45	In the case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades		No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades		No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades		No	
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What are the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 10: Polish Pavilion, Expo 2010

Structured information					
Building location:	Shanghai-China	Architect/s:	WWAA Architects	Site topography:	Flat Land
Construction date/s:	2010	Site context:	Urban	Climatic zone:	Moderate climate
Building use:	Public / Cultural	Users group:	All genders-All ages	Floors number:	2 Floors

Visual information	Textual information
 	The pavilion features a perforated façade, inspired by traditional Polish folk art paper cut-outs, it is made of CNC-cut plywood mounted on a steel structure. The cultural idiom is primarily conveyed through the theme, the motif of the folk-art paper cut-out. It provides visitors with comparable experience by shaping the outer skin patterning in such a way that the sun rays shining through would chisel, by light and shade, the space under the vault. The structure's overall shape, with many slanting planes, on the one hand complements and rounds out, by the suggestion of a folded sheet of paper, the 'cut-out' narrative, on the other creates a geometrically intriguing and flexible space that can be creatively apportioned, by inner divisions, to different exhibition, performance and utility functions and uses. The story that the patterns are supposed to tell is the base for the presented images and films showing Poland through its history, culture, economy and everyday life. The design of the cut-outs goes with the presented on its contents changing along the visitors' route. The building comprises a series of slanting planes to suggest a folded sheet of paper.
Ref:<http://www.dezeen.com/2010/06/03/polish-pavilion-for-shanghai-expo-2010-by-wwaa-architects/>, (03/2015).	*Ref:<http://www.dezeen.com/2010/06/03/polish-pavilion-for-shanghai-expo-2010-by-wwaa-architects/>, (03/2015).*

Technological data of the perforated envelope

Construction & perforation parameters

	Question	Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Plywood		
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	NA	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope

Passive design parameters

	Question	Answer options				
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others

Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Variant
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				
Active design parameters							
Question		**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there are no open-able elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In the case of double-skin, does the air cavity impede or obscure occupants' view-ability to the outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In the case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What are the perforated material's relative initial costs?	High	Moderate	Low	NA		
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		

Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 11: Danish Pavilion, Expo 2010

Structured information

Building location:	Shanghai-China	Architect/s:	BIG	Site topography:	Flat Land
Construction date/s:	2010	Site context:	Urban	Climatic zone:	Moderate climate
Building use:	Public / Cultural	Users group:	All genders-All ages	Floors number:	3 Floors

Visual information

Ref:<http://bywojtek.net/portfolio-item/shanghai-expo2010/>,(06/2015).

Textual information

Danish Pavilion we have attempted to consolidate a handful of real experiences of how a sustainable city - such as Copenhagen - can, in fact, increase the quality of life, it is designed as a traffic loop created by the motion of city bikes and pedestrians tied in a knot. The pavilion is a monolithic structure in white painted steel which keeps it cool during the Shanghai summer sun due to its heat-reflecting characteristics. The roof is covered with a light blue surfacing texture, known from Danish cycle paths. Inside, the floor is covered with light epoxy and also features the blue cycle path where the bikes pass through the building. The steel of the facade is perforated in a pattern that reflects the actual structural stresses that the pavilion is experiencing making it a 1:1 stress test. The blue cycle path and white concrete surfaces define the arrival and exit areas.

Ref: < http://www.dezeen.com/2010/05/01/danish-pavilion-at-shanghai-expo-2010-by-big/>, (02/2015).

Technological data of the perforated envelope

Construction & perforation parameters

Question		Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	NA	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				

Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA	
Environmental indicators of the perforated envelope							
Passive design parameters							
Question		**Answer options**					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				
Active design parameters							
Question		**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there are no openable elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In the case of double-skin, does the air cavity impede or obscure occupants' view-ability to the outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In the case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		

Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What are the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 12: Russian Pavilion, Expo 2010

Structured information

Building location:	Shanghai-China	Architect/s:	P.A.P. ER	Site topography:	Flat Land
Construction date/s:	2010	Site context:	Urban	Climatic zone:	Moderate climate
Building use:	Public / Cultural	Users group:	All genders-All ages	Floors number:	5 Floors

Visual information

Ref:<https://www.flickr.com/photos/23665309@N02/4570345226/>, (06/2015).

Textual information

The architects were challenged to propose Russia's national pavilion that would fit the theme of the exhibition "Better City - Better Life" and also articulate the modern image of Russia. The project was based on the idea of the tripartite principle of world order, an idea that is close both to Russian and Chinese cultures. The three-level pavilion presents the idea of harmonious development in a modern city. The Park on the ground level resembles Nature, Past, and Earth. The middle level's snowy platform is a reminder of civilization, Present, and human. The roof level with the open towers symbolizes cities, future, and sky, and also represents the legendary city of Buyan Grad. The Russian pavilion today is a group of twelve white towers with a red and gold ornamental pattern symbolizing a rich historical and cultural heritage, rapid development and the growth of a modern, multinational country. The towers encompass a cubic mass, which houses the main exposition hall of the Russian Pavilion. This is the so-called "Energy Centre" of the pavilion, from where the towers "grow." From their monolithic base, they grow to become an irregularly light structure at their upper part.

Ref:<http://www.graphisoft.com/info/news/press_releases/russian-pavilion-shanghai.html>, (03/2015).

Technological data of the perforated envelope									
Construction & perforation parameters									
Question		**Answer options**							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	

Q.6	What is the number of perforated layers in the envelope?	1	2	More				
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated		
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels					
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	NA
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others		
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant			
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays					
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant		
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant		
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA		
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces			
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA		
Environmental indicators of the perforated envelope								
Passive design parameters								
Question		**Answer options**						
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others		
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others		
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios		
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No				
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant		
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA			
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA			
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA			
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Variant	
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA			
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA			
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No					
Active design parameters								
Question		**Answer options**						
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA		
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA				
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA			
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others				
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA				
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA				
Socio-cultural indicators of the perforated envelope								
Usability, adaptability, and connectivity								
Question		**Answer options**						
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA				
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA			
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA			
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there are no open-able elements?	Yes	Slightly	Not in all facades	No	NA		

Q.41	In the case of double-skin, does the air cavity impede or obscure occupants' view-ability to the outside?	Yes	Slightly	Not in all facades	No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No	
Q.45	In the case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No	
Economic indicators of the perforated envelope						
Initial costs, running costs, and maintainability						
Question		**Answer options**				
Q.48	What are the perforated material's relative initial costs?	High	Moderate		Low	NA
Q.49	Does the perforation technique have independent costs?	Yes	No	NA		
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA		
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA	
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA	
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA	
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA	
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA	
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA	
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA	
Q.58	Is the perforated layer easily cleanable?	Yes	No			
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA		
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No			

Case 13: Fraunhofer Transfer Centre

Structured information

Building location:	Darmstadt-Germany	Architect/s:	JSWD	Site topography:	Flat Land
Construction date/s:	2010	Site context:	Suburban	Climatic zone:	Moderate climate
Building use:	Public / Cult-Educational	Users group:	All Genders-Young/old	Floors number:	4 Floors

Visual information	Textual information
	The architects focused on an appropriate integration of the compact, ashlar-shaped volume into the tradition of the already existing architecture. The development of the façade was by manufacturing brass plates, so-called bond-brass tables, the peculiarity of the façade is the combination of sandwich elements and brass plates. The material reacts to sunlight and displays very different faces, depending on the circumstances. The range is from dark and gray down to bright and shining. A perforation of the façade through a small square opening loosens up the building and brings light inside, Along the window rows there are exterior wall panels sticking out from the façade, made from the same material as the façade plates. Through this, the building gets more depth and variation, behind the brass façade there is windows flush with the adjacent areas, the façade has actively mechanically responding function continued from the outside towards the inside. Supporting outside walls made of concrete as well as ceilings, a concrete core temperature control was planned, used for heating and cooling. In addition, the warm roof with its intense green area is responsible for another natural temperature control inside.
Ref: <http://www.jswd-architekten.de/en/projects/educationresearch/fraunhofertransfercenteradaptronictzadarmstadt/>, (06/2015).	*Ref: <http://architecture.mapolismagazin.com/jswd-architekten-adaptronik-transfer-center-darmstadt-germany>, (06/2015).*

Technological data of the perforated envelope

Construction & perforation parameters

Question		Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	NA	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope

Passive design parameters

	Question	Answer options					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				

Active design parameters

	Question	Answer options				
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA		
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA	
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others		
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA		
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA		

Socio-cultural indicators of the perforated envelope

Usability, adaptability, and connectivity

	Question	Answer options				
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA		
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there are no open-able elements?	Yes	Slightly	Not in all facades	No	NA
Q.41	In the case of double-skin, does the air cavity impede or obscure occupants' view-ability to the outside?	Yes	Slightly	Not in all facades	No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No	
Q.45	In the case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No	

Economic indicators of the perforated envelope

Initial costs, running costs, and maintainability

	Question	Answer options				
Q.48	What are the perforated material's relative initial costs?	High	Moderate	Low	NA	

Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 14: San Telmo Museum Extension

Structured information

Building location:	Madrid-Spain	Architect/s:	Nieto Sobejano	Site topography:	Mountainous
Construction date/s:	2011	Site context:	Suburban	Climatic zone:	Moderate climate
Building use:	Public / Cultural	Users group:	All genders-All ages	Floors number:	3 Floors

Visual information

Ref:<http://www.archiportale.com/news/2012/05/architettura/san-telmo-il-museo-firmato-nieto-sobejano-arquitectos_27539_3.html>, (01/2015).

Textual information

The Museum of San Telmo, in its present condition, represents the result of a long process of successive modifications which has partially altered its physical and functional character over the years. Its location on the fringe where the urban structure meets the topography of Monte Urgull is a reflection, on the other hand, of an urban problem very characteristic of San Sebastian: the solution of a division never completely solved between natural and artificial landscape. One concept was the building of a new green wall, deep and light, which is defined by the existing topography, and which hides in its interior two pavilions which will house the new program. This decision heightens the appreciation both of the historical buildings as well as the new entrance to the museum which offers access to the old building. A "green wall": on certain occasions, the metaphor associated with an architectural idea gives a sense to each and every aspect of the project. Hence the slight changes of direction of the wall are sufficient to provide a natural solution to pedestrian access to Monte Urgull, to configure an open-air exhibition space, or to house a café-terrace open to the landscape and to the town. The new building screen is defined by a perforated metal skin enveloped in moss, lichen and other plant species which finally will come to surround the whole building. This is considered as an unusual intervention in a public area which represents a common field of action between plastic arts and architecture. The new extension of the San Telmo Museum modifies its appearance with the passing of the seasons: it fades on occasions and blends with the vegetation on the hill.

Ref: <http://aasarchitecture.com/2013/02/san-telmo-museum-extension-by-nieto-sobejano-arquitectos.html>, (01/2015).

Technological data of the perforated envelope

Construction & perforation parameters

Question		Answer options						
Q.1	What is the type of intervention of the perforated envelope?	Newly added		Previously built				
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More		

Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			
Environmental indicators of the perforated envelope									
Passive design parameters									
Question		**Answer options**							
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others			
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others			
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios			
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No					
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant			
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA				
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA				
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA				
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Variant		
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA				
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA				
Q.30	Are there other used passive design techniques/elements?	Yes: planted walls	No						
Active design parameters									
Question		**Answer options**							
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA			
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA					
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA				
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others					
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA					
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA					
Socio-cultural indicators of the perforated envelope									
Usability, adaptability, and connectivity									
Question		**Answer options**							
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA					
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA				

Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades		NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades		No	NA
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades		No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades		No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades		No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades		No	
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades		No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades		No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades		No	
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 15: Kolumba Museum					
Structured information					
Building location:	Cologne-Germany	Architect/s:	Peter Zumthor	Site topography:	Flat Land
Construction date/s:	2008	Site context:	Urban	Climatic zone:	Moderate climate
Building use:	Public / Cultural	Users group:	All genders-All ages	Floors number:	3-4 Floors

Visual information	**Textual information**
 	The building completely surrounds the ruins of the church and in fact merges with them while using the upper level and a side wing to house the exhibit areas. Externally, the building is characterized by its massiveness, a simple and severe composition of warm-coloured volumes and thus integrates both to its urban context as well as the historic site where is located. However, despite this massiveness, the building is surrounded by garden areas that allow the space to permeate within the urban fabric. The texture of thin gray brick, handmade by Tegl Petersen of Denmark, frames the remains of the old chapel achieving a remarkable integration between new and old. Part of the success in this fusion lies in the simplicity of form, color and material that embed these Gothic-style fragments. Another noticeable feature is the perforations on the facade, forming a kind of lattice made on the basis of the bricks themselves. This effect lightens the perception of the volume. t is however in the interior of the building where Zumthor's work can be better appreciated. The architect has wrapped both the octagonal chapel as well as the Roman ruins with a double height nave supported by thin metal columns. This monumental space is dramatically lit up since indirect light filters through the lattice in the walls. The visitor is able to walk throughout the chapel by means of a winding passage which lies over the ruins. The building also opens its views to some courts designed in a serene Zen minimalism, which houses works by famous sculptors like Richard Serra and Joseph Wolf.
Ref: <http://architecturalmoleskine.blogspot.ca/2012/04/peter-zumthor-kolumba-museum-cologne.html>, (04/2015).	*Ref: <http://architecturalmoleskine.blogspot.ca/2012/04/peter-zumthor-kolumba-museum-cologne.html>, (04/2015).*

Technological data of the perforated envelope

Construction & perforation parameters

	Question	Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Brick	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	NA	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope							
Passive design parameters							
Question		**Answer options**					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				

Active design parameters							
Question		**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			

Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In the case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		

Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What are the perforated material's relative initial costs?	High	Moderate	Low	NA		
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			

Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 16: Moderna Museet Malmö

Structured information

Building location:	Malmö-Sweden	Architect/s:	Tham &Videgård	Site topography:	Flat Land
Construction date/s:	2008-2009	Site context:	Urban	Climatic zone:	Moderate climate
Building use:	Public / Cultural	Users group:	All genders-All ages	Floors number:	2 Floors

Visual information

Ref:<http://www.archdaily.com/55428/moderna-museet-malmo-tham-videgard-arkitekter>, (01/2015).

Textual information

As being seen from the exterior, a new extension marks the arrival of the new museum. The extension provides a new entrance and reception space, as well as a cafeteria and a new upper gallery. Its perforated orange façade both connects to the existing brick architecture and introduces a contemporary element to the neighborhood, the perforated surface gives the façade a visual depth, and is animated through the dynamic shadow patterns which it creates, the ground floor is fully glazed so that sunlight is screened through the perforated façade. In relation to its context, from a distance it is only intelligible in comparison to the adjacent houses, only on close proximity the building and details can be read in its own right.

Ref:<http://www.archdaily.com/55428/moderna-museet-malmo-tham-videgard-arkitekter>, (01/2015).

Technological data of the perforated envelope

Construction & perforation parameters

Question		Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			

Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces		
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA	
Environmental indicators of the perforated envelope							
Passive design parameters							
Question		**Answer options**					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	50:1
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				
Active design parameters							
Question		**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		

Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 17: Museum of Archaeology

Structured information

Building location:	Seró-Spain	Architect/s:	Toni Girones	Site topography:	Hilly Land
Construction date/s:	2012	Site context:	Suburban	Climatic zone:	Moderate climate
Building use:	Public / Cultural	Users group:	All genders-All ages	Floors number:	1 Floor

Visual information

Ref:<http://www.archilovers.com/projects/88780/gallery?667837>, (03/2015).

Textual information

The museum was constructed with only three visible materials, which at first sight lend it a rough appearance. The bays of the concrete skeleton frame are filled with red brickwork. The paving consist of bricks and brick chippings and the balustrades and gratings are made of rusted reinforcing steel. In the one room, empty corked bottles were inserted in the openings of the cored brick facade, creating a simple form of glazing for the winter months. In summer, individual bottles can be removed to allow ventilation. The exhibition begins with a space containing display panels and smaller objects in showcases, all illuminated by cylindrical light fittings suspended from the ceiling. Here, wind and mist are perceptible through the layers of the cored brick walls. On leaving this central space on the opposite side, the labyrinthine route continues in the reverse direction to the exit and comes to an end in a cornfield.

Ref: <http://www.detail-online.com/inspiration/museum-of-archaeology-in-sero-111715.html>, (02/2015).

Technological data of the perforated envelope									
Construction & perforation parameters									
Question		**Answer options**							
Q.1	What is the type of intervention of the perforated envelope?	Newly added		Previously built					
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			

Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Brick + Glass
Q.9	How was the perforation created?	By interlocking of blocks		By drilling the panels			
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	NA
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others	
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant		
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays				
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant	
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant	
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA	
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces		
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA	

Environmental indicators of the perforated envelope

Passive design parameters

Question		Answer options					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				

Active design parameters

Question		Answer options				
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA		
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA	
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others		
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA		
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA		

Socio-cultural indicators of the perforated envelope

Usability, adaptability, and connectivity

Question		Answer options				
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA		
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No	

Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No	
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No	
Economic indicators of the perforated envelope						
Initial costs, running costs, and maintainability						
Question		**Answer options**				
Q.48	What are the perforated material's relative initial costs?	High	Moderate		Low	NA
Q.49	Does the perforation technique have independent costs?	Yes	No	NA		
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA		
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA	
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA	
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA	
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA	
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA	
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA	
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA	
Q.58	Is the perforated layer easily cleanable?	Yes	No			
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA		
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No			

Case 18: Le MuCEM (Museum of European and Mediterranean Civilizations)

Structured information					
Building location:	Marseille-France	Architect/s:	Rudy Ricciotti	Site topography:	Flat Land
Construction date/s:	2013	Site context:	Urban	Climatic zone:	Moderate climate
Building use:	Public / Cultural	Users group:	All genders-All ages	Floors number:	4-5 Floors

Visual information	**Textual information**
	For this first museum worldwide dedicated to the Mediterranean cultures (MuCEM), laying on the waterfronts of Marseille, at the Old Port entrance, on the former port jetty J4, the architect designed an exceptional building open on the sea, and able to install a dialogue between the two shores of the Mediterranean Sea and open a new horizon for Marseille inhabitants. A 15,000m² mineral cube where concrete gives all its strength and lightness to the building. The ornamental concrete shrouds the glazed exterior of the museum like a lacy veil, moderating light through to the building's two exhibition floors. Meanwhile, an inclined walkway bridge links the roof of the building to meet Saint-Jean Fort that houses the museum exhibitions. "Nothing in this work is purely decorative. Everything is structural, just like a fish skeleton. We progress towards a dematerialization of the concrete structure which becomes delicate, long and thin, energetic like a coral rock" concludes Ricciotti. The architect wanted a place for a stroll and a place of culture, a popular museum offering a different trip through the Mediterranean Sea" explains architect.
Ref: <http://www.urdesign.it/index.php/2013/06/05/mucem-the-museum-of-european-and-mediterranean-civilizations-by-rudy-ricciotti/>, (06/2015).	*Ref: <http://www.urdesign.it/index.php/2013/06/05/mucem-the-museum-of-european-and-mediterranean-civilizations-by-rudy-ricciotti/>, (06/2015).*

Technological data of the perforated envelope

Construction & perforation parameters

	Question	Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	NA	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope

Passive design parameters

	Question	Answer options					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Variant
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				

Active design parameters

	Question	Answer options				
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA		
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA	
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others		
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA		

Q.36	Are there other used active design techniques/elements?	Yes: specify		No	NA		
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials		NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades		NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there are no open-able elements?	Yes	Slightly	Not in all facades		No	NA
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades		No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades		No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades		No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades		No	
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades		No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades		No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades		No	
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What are the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 19: Islamic Museum of Australia

Structured information

Building location:	Melbourne-Australia	Architect/s:	Desypher	Site topography:	Flat Land
Construction date/s:	2014	Site context:	Urban	Climatic zone:	Moderate climate
Building use:	Public / Cultural	Users group:	All genders-All ages	Floors number:	2 Floors

Visual information	Textual information
 	The designers were adamant to resist the temptation to assemble a shallow interpretation of iconic Islamic symbols and plonk it on the banks of the Merri Creek. Instead, they created something that first and foremost reflects the context of its location and at the same time is crafted out of traditional design principles and methodologies. The Museum's entry is defined by a veil of the rusted wall that wraps around the exterior. It encompasses many layers of meaning; it is a material that is Australian, rugged and weathered. The perforated pattern is a modernized reference to indigenous dot painting and tells the story of Muslims in Australia dating back to peaceful Makassan contact with the first Australians. The perforations allow filtered light to stream into the entry area and create a magical effect as the transposed dots of light transcribe the movement of the sun onto floor and wall surfaces. Interestingly at night when space is internally lit, beams of light filter outwards interrupted only by the movement of people within. The rusted veil is set against a pristine prism delineated with a geometric pattern that is the flattened out origami construction of a sphere referencing the oneness of God.
Ref:<http://aasarchitecture.com/2014/04/islamic-museum-australia-desypher.html>, (06/2015).	*Ref:<http://aasarchitecture.com/2014/04/islamic-museum-australia-desypher.html>, (06/2015).*

Technological data of the perforated envelope

Construction & perforation parameters

	Question	Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope

Passive design parameters

	Question	Answer options				
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others

Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Variant
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				

Active design parameters

	Question	Answer options					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			

Socio-cultural indicators of the perforated envelope

Usability, adaptability, and connectivity

	Question	Answer options				
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA		
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there are no open-able elements?	Yes	Slightly	Not in all facades	No	NA
Q.41	In the case of double-skin, does the air cavity impede or obscure occupants' view-ability to the outside?	Yes	Slightly	Not in all facades	No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No	
Q.45	In the case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No	

Economic indicators of the perforated envelope

Initial costs, running costs, and maintainability

	Question	Answer options			
Q.48	What are the perforated material's relative initial costs?	High	Moderate	Low	NA
Q.49	Does the perforation technique have independent costs?	Yes	No	NA	
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA	
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA

Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 20: Leiner Furniture Store

Structured information

Building location:	Innsbruck-Austria	Architect/s:	Zechner & Zechner	Site topography:	Flat Land
Construction date/s:	2012	Site context:	Suburban	Climatic zone:	Moderate climate
Building use:	Public / Commercial	Users group:	All genders-All ages	Floors number:	4 Floors

Visual information

Ref: <http://www.e-architect.co.uk/austria/leiner-furniture-store>, (02/2015).

Textual information

The ground floor is slightly raised, by about 1m, from the surrounding ground level, in order to provide natural illumination and ventilation to the underground parking. Daylight enters via the gap, which helps prevent the impression of a closed-off and dark garage. The thermally active facade is predominantly formed of sandwich panels. Display windows are used only in limited areas, including opening the building's closed skin, at a busy corner on a roundabout, with a two-story glass facade that gives a view of the furniture store's range. The external shape of the building is primarily created by a suspended projecting facade, which lies like an angular cloth above the geometrically simple structure below. This external skin is 'pulled up' in particular areas, the prismatic facade of perforated aluminum sheets produces different reflections, depending on facade angle, reduces the building's mass and gives the building a very striking exterior. An abstract perforation pattern was developed for the outer envelope, the perforations are larger where the rooms behind are illuminated by windows and smaller in other areas to prevent climbing. In particular areas, the perforations also trace out the three-swan logo. The facade cavity is illuminated in the evening, continually altering the appearance of the building as the lighting changes, the outer envelope then appears lighter and as transparent as a curtain, and the building's volumes start to light up. Using innovative building services technology, resources are conserved and energy use and CO_2 emissions reduced, as a comparison: the reductions in CO_2 emissions made by the project using innovative building services technology is equivalent to 80 average, 150 m2, detached homes with oil heating.

Ref: <http://www.e-architect.co.uk/austria/leiner-furniture-store>, (02/2015).

Technological data of the perforated envelope

Construction & perforation parameters

	Question	Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			

Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels					
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others		
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant			
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays					
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant		
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant		
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA		
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces			
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA		

Environmental indicators of the perforated envelope

Passive design parameters

	Question	Answer options					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Variant
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				

Active design parameters

	Question	Answer options				
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA		
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA	
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others		
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA		
Q.36	Are there other used active design techniques/elements?	Yes: CO2 reduction	No	NA		

Socio-cultural indicators of the perforated envelope

Usability, adaptability, and connectivity

	Question	Answer options				
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA		
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there are no open-able elements?	Yes	Slightly	Not in all facades	No	NA
Q.41	In the case of double-skin, does the air cavity impede or obscure occupants' view-ability to the outside?	Yes	Slightly	Not in all facades	No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No	

Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No	
Q.45	In the case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No	

Economic indicators of the perforated envelope

Initial costs, running costs, and maintainability

Question		Answer options				
Q.48	What are the perforated material's relative initial costs?	High	Moderate		Low	NA
Q.49	Does the perforation technique have independent costs?	Yes	No	NA		
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA		
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA	
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA	
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA	
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA	
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA	
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA	
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA	
Q.58	Is the perforated layer easily cleanable?	Yes	No			
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA		
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No			

Case 21: L'Atoll Angers

Structured information

Building location:	Angers-France	Architect/s:	Antonio Virga & AAVP	Site topography:	Flat Land
Construction date/s:	2012	Site context:	Suburban	Climatic zone:	Moderate climate
Building use:	Public / Commercial	Users group:	All genders-All ages	Floors number:	2 Floors

Visual information

Ref:<http://www.archdaily.com/270696/latoll-angers-antonio-virga-architecte-aavp-architecture>, (04/2015).

Textual information

L'Atoll Angers is a kind of 'shopping stadium' in which stores are grouped together in such a way as to avoid monotonous distribution along straight lines. The continuous line of the building's slightly irregular elliptical shape opens at the four compass points in large arched entrances that offer views into the immense green space of the 'lagoon' inside. The building envelope is pearly white perforated aluminum with backlighting, giving a unity to the entire structure, with its thermal lacquer finish reflecting the light and the surrounding landscape. The envelope comprises several bands: Up to ten feet (3 m), the diameter of the perforations is very small to block the view from outside, while from ten to thirty-three feet (3–12 m), the perforations are diamond shaped and different sizes. From thirty-three feet upward, the facade curves inwards, forming a canopy over the glazed walls that mark off the shops and the concourses. To comply with fire safety regulations, the center of the ellipse is open. The envelope hides the less glamorous technical installations, with an attractive finish on both the inside and outside. It also provides a high level of environmental comfort, reducing the impact of west winds, improving thermal comfort by acting as sun shading, and, because of the cocoon effect created by its shape, reducing noise pollution. Sustainable development was a focus of the entire design process, Certivéa awarded the building HQE certification for high environmental quality in non-residential buildings.

Ref:<http://www.theplan.it/eng/webzine/architettura-internazionale/qlatollq>, (06/2015).

Technological data of the perforated envelope

Construction & perforation parameters

	Question	Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	NA	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope

Passive design parameters

Question		Answer options				
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No		
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA	
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA	
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA	
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Variant
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA	
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA	
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No			

Active design parameters

Question		Answer options				
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA		
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA	
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others		
Q.35	Does the building have some awards/certificates?	Yes: HQE certification	No	NA		
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA		

Socio-cultural indicators of the perforated envelope

Usability, adaptability, and connectivity

Question		Answer options				
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA		
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No	
Q.45	In the case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No	

Economic indicators of the perforated envelope

Initial costs, running costs, and maintainability

Question		Answer options				
Q.48	What are the perforated material's relative initial costs?	High	Moderate	Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA		

Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA				
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA			
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA			
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA			
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA			
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA			
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA			
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA			
Q.58	Is the perforated layer easily cleanable?	Yes	No					
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA				
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No					

Case 22: Dubai Tower "O - 14"

Structured information

Building location:	Dubai-UAE	Architect/s:	Reiser & Umemoto	Site topography:	Flat Land
Construction date/s:	2006-2012	Site context:	Urban	Climatic zone:	Dry Arid
Building use:	Public / Commercial	Users group:	All genders-All ages	Floors number:	22 Floors

Visual information

Ref: <http://www.e-architect.co.uk/dubai/o14-tower>, (04/2015).

Textual information

The design of O-14 fundamentally shifts away from the architectural norm in current Dubai towers by eliminating the now obligatory curtain wall and above ground parking in favor of a shade-producing, concrete load-bearing shell and an open public space at the tower base achieved by moving the parking below ground. High-strength self-consolidating concrete was cast around a basket weave of steel reinforcement resulting in an elegant perforated exterior shell, the holes are achieved by introducing computer numerically cut polystyrene void forms into the rebar matrix, and sided with modular steel slip forms prior to the concrete pour, the concrete shell provides an efficient structure that frees the core from the burden of lateral forces and creates highly efficient, column-free open spaces in the building's interior. The shell is not only the structure of the building but acts on the interiors as a sunscreen open to light, air, and views, the openings on the shell are modulated depending on structural requirements, views, sun exposure, and luminosity. A space nearly one-meter-deep between the shell and the glazing creates a 'chimney effect,' a phenomenon whereby hot air has room to rise and effectively cools the surface of the window wall behind the perforated shell, this passive solar technique essentially contributes to a natural component to the cooling system for O-14, thus reducing energy consumption by 30%, just one of many innovative aspects of the building's design.

Ref: <http://www.e-architect.co.uk/dubai/o14-tower>, (04/2015).

Technological data of the perforated envelope

Construction & perforation parameters

	Question	Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					

Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated		
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels					
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others		
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant			
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays					
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant		
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant		
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA		
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces			
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA		
Environmental indicators of the perforated envelope								
Passive design parameters								
Question		**Answer options**						
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others		
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others		
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios		
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No				
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant		
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA			
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA			
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA			
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Variant	
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA			
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA			
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No					
Active design parameters								
Question		**Answer options**						
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA		
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA				
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA			
Q.34	Does the perforation need technology for manufacturing?	Yes: on-site works	No: manually created	Others				
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA				
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA				
Socio-cultural indicators of the perforated envelope								
Usability, adaptability, and connectivity								
Question		**Answer options**						
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA				
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA			
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA			
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there are no open-able elements?	Yes	Slightly	Not in all facades	No	NA		
Q.41	In the case of double-skin, does the air cavity impede or obscure occupants' view-ability to the outside?	Yes	Slightly	Not in all facades	No	NA		

Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No	
Q.45	In the case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No	
Economic indicators of the perforated envelope						
Initial costs, running costs, and maintainability						
Question		**Answer options**				
Q.48	What are the perforated material's relative initial costs?	High	Moderate		Low	NA
Q.49	Does the perforation technique have independent costs?	Yes	No	NA		
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA		
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA	
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA	
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA	
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA	
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA	
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA	
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA	
Q.58	Is the perforated layer easily cleanable?	Yes	No			
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA		
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No			

Case 23: Trollbeads Jewelry Building

Structured information					
Building location:	Copenhagen-Denmark	Architect/s:	BBP Arkitekter	Site topography:	Flat Land
Construction date/s:	2014	Site context:	Urban	Climatic zone:	Moderate climate
Building use:	Public / Commercial	Users group:	All genders-All ages	Floors number:	6 Floors

Visual information

Ref:<http://www.dezeen.com/2014/05/19/trollbeads-house-by-bbp-arkitecter-copenhagen/>, (05/2015).

Textual information

This 1960s building in Copenhagen has a new layer of perforated brass wraps over the walls and around the roof to sit comfortably between the 18th century buildings on either side by mimicking their scale and mass, but using modern materials to make it more contemporary. The architects removed the original facade and extended the concrete structure 2.5 meters toward the street, bringing it in line with the buildings on either side. Then they added a glazed curtain wall around the front, back and roof, and covered it top-to-bottom in perforated brass shutters, half the shutters are left open, which creates the illusion of evenly spaced windows like those of the surrounding buildings. After working hours, the curtain closes automatically, and the building is transformed into a burglar-proof vault. Then after dark a dim light turns on inside, revealing a modern glass house behind a veil of translucent brass.

Ref:<http://www.dezeen.com/2014/05/19/trollbeads-house-by-bbp-arkitecter-copenhagen/>, (05/2015).

Technological data of the perforated envelope								
Construction & perforation parameters								
Question		**Answer options**						
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built					
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More		
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None	
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others
Q.6	What is the number of perforated layers in the envelope?	1	2	More				
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated		
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels					
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others		
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant			
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays					
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant		
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant		
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA		
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces			
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA		
Environmental indicators of the perforated envelope								
Passive design parameters								
Question		**Answer options**						
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others		
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others		
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios		
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No				
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant		
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA			
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA			
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA			
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others	
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA			
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA			
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No					
Active design parameters								
Question		**Answer options**						
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA		
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA				
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA			
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others				
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA				

Q.36	Are there other used active design techniques/elements?	Yes: specify			No	NA	
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials		NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades		NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades		No	NA
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades		No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades		No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades		No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades		No	
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades		No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades		No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades		No	
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 24: Lightmos Company					
Structured information					
Building location:	Bangkok-Thailand	Architect/s:	Architectkidd	Site topography:	Flat Land
Construction date/s:	2006-2008	Site context:	Urban	Climatic zone:	Tropical climate
Building use:	Public / Office building	Users group:	All genders-All ages	Floors number:	4 Floors

Visual information	**Textual information**
	The design objective was to create a new exterior layer to prevent the direct transmission of heat and outside light, while maintaining permeable qualities, the building features a perforated white aluminium-composite facade, with the circular off-cuts used as seats for stools. After experimenting with different materials and techniques, the selected facade material was white aluminium composite, an inexpensive but workable material. Circular holes were used as a kind of an optimization technique because it was an efficient way to create a closed shape, and it minimized the machine cutting time for the facade panels. To redirect the material off cuts from the building site, a cross-disciplinary approach was needed. Architectkidd collaborated with product designers Osisu to create a series that could integrate the aluminium "holes" into furniture design. Along with the aluminium off-cuts, scrap wood collected from other construction sites in Bangkok was utilized to form the support base of the seating.
Ref: <http://www.dezeen.com/2009/12/20/furniture-from-buildings-by-architectkidd-and-osisu/>, (03/2015).	*Ref: <http://www.dezeen.com/2009/12/20/furniture-from-buildings-by-architectkidd-and-osisu/>, (03/2015).*

Technological data of the perforated envelope

Construction & perforation parameters

	Question	**Answer options**							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	**Previously built**						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	**4 faces**	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	**4 faces**	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	**SE**	**SW**	**NE**	**NW**
Q.5	What is the shape of the perforated faces of the envelope?	**Flat**	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	**1**	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	**Not perforated**			
Q.8	What is the type of perforated material?	Wood	Concrete	**Metal**	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	**By drilling the panels**						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	**Glass**	Others	
Q.11	What is the perforation pattern shape?	**Primitive geometries**	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	**Variant**				
Q.13	What is the configuration type of perforation	**Regular arrays**	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	**11-35%**	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	**1- 9 mm**	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	**<0.59m**	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	**No**	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	**NA**			

Environmental indicators of the perforated envelope

Passive design parameters

	Question	**Answer options**				
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	**Aesthetic**	Conceptual	Others
Q.20	What is the purpose of orientating the perforated facades?	Environmental	**Not considered**	Inevitable	Conceptual	Others

Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	**11-35%**	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	**Slightly**	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	**Man-made common**	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	**Low**	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	**No**	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	**Yes: specify**	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	**Variant**
Q.28	What is the level of material's resistance to moisture and rain?	High	**Moderate**	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	**Slightly**	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	**No**				
	Active design parameters						
	Question	**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	**NA**	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	**NA**			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	**Slightly**	No	NA		
Q.34	Does the perforation need technology for manufacturing?	**Yes: prefabricated panels**	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: specify	**No**	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	**No**	NA			
	Socio-cultural indicators of the perforated envelope						
	Usability, adaptability, and connectivity						
	Question	**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	**No**	NA			
Q.38	Is the perforated material commonly used by the community?	**Yes**	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	**No**	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	**Yes**	Slightly	Not in all facades	No	NA	
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	**Yes**	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	**Yes**	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	**Yes**	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	**Yes**	Slightly	Not in all facades	No		
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	**Yes**	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	**Yes**	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	**Yes**	Slightly	Not in all facades	No		
	Economic indicators of the perforated envelope						
	Initial costs, running costs, and maintainability						
	Question	**Answer options**					
Q.48	What is the perforated material's relative initial costs?	**High**	Moderate	Low	NA		
Q.49	Does the perforation technique have independent costs?	**Yes**	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	**NA**			
Q.51	Do the perforations decrease the building's running costs?	Yes	**Slightly**	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	**Slightly**	No	NA		
Q.53	Is the perforated material locally available?	**Yes**	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	**Yes**	Slightly	No	NA		

Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 25: The Orange Cube

Structured information

Building location:	Lyon-France	Architect/s:	Jakob & Macfarlane	Site topography:	Flat Land
Construction date/s:	2005-2011	Site context:	Urban	Climatic zone:	Moderate climate
Building use:	Public / Office building	Users group:	All genders-All ages	Floors number:	6 Floors

Visual information

Ref: <http://www.dezeen.com/2011/03/02/the-orange-cube-by-jakob-macfarlane/>, (04/2015).

Textual information

The building features a coloured metal mesh façade, perforated with circles of different sizes. Full-height walls with polygonal apertures have been inserted throughout the showroom, with items displayed in the holes. The project was designed as a simple orthogonal (cube) into which a giant hole is carved, responding to necessities of light, air movement and views, this hole creates a void, piercing the building horizontally from the river side inwards and upwards through the roof terrace. The cube, next to the existing hall highlights its autonomy, it was designed on a regular framework (29 x 33m) made of concrete pillars on 5 levels. A light façade, with seemingly random openings is completed by another facade, pierced with pixilated patterns that accompany the movement of the river, the orange colour refers to lead paint, an industrial colour often used for harbour zones. In order to create the void, Jakob and MacFarlane worked with a series of volumetric perturbations, linked to the subtraction of three "conic" volumes disposed on three levels: the angle of the façade, the roof and the level of the entry, the plan of the façade is hence shifted towards the interior, constructing a new relation to light and view, from both interior and exterior. The project is part of the approach for sustainable development and respects the principles of optimization of the façade conception allowing to reconcile thermal performance and visual comfort with an Ubat <0,7 w/m2 K and a daylight factor of 2% for almost the total number of offices, a thermo-frigorific production through heat pumps on the water level and the replacement of new hygienic air with recuperation of high efficient calories of the extracted air.

Ref: <http://www.dezeen.com/2011/03/02/the-orange-cube-by-jakob-macfarlane/>, (04/2015).

Technological data of the perforated envelope

Construction & perforation parameters

Question		Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						

Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others		
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant			
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays					
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant		
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant		
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA		
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces			
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA		
Environmental indicators of the perforated envelope								
Passive design parameters								
Question		**Answer options**						
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others		
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others		
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios		
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No				
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant		
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA			
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA			
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA			
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Variant	
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA			
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA			
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No					
Active design parameters								
Question		**Answer options**						
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA		
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA				
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA			
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others				
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA				
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA				
Socio-cultural indicators of the perforated envelope								
Usability, adaptability, and connectivity								
Question		**Answer options**						
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA				
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA			
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA			
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA		
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA		
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No			
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No			
Q.44	Do the perforation ratios and proportions enhance the	Yes	Slightly	Not in all facades	No			

	acoustical insulation performance of the envelope?					
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No	

Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 26: U15 Office Building

Structured information					
Building location:	Milan-Italy	Architect/s:	Cino Zucchi Architetti	Site topography:	Flat Land
Construction date/s:	2011	Site context:	Urban	Climatic zone:	Moderate climate
Building use:	Public / Offices	Users group:	All genders-All ages	Floors number:	15 Floors

Visual information

Ref: <http://www.archello.com/en/project/u15-office-building>, (05/2015).

Textual information

The disposition on the ground and the typological layout of the U15 office building articulate and specify the general master plan guidelines in relationship to the specific features of the site and of the overall design of the open spaces. The large dimension of the building plot and the maximum building envelope were given by the master plan is interpreted by folding its perimeter inwards to generate a new layout which unites the advantages of an H-shaped scheme to that of a centralized one. The continuous perimeter "skin" which delimits the interior spaces is divided in several layers which donates depth and a strong light and shadow effect: the inner wall alternates a ribbon window band with an opaque one faced by anodized aluminium panels in natural warm grey, pale gold, light brown shades. The exterior system of aluminium sheets folded in different profiles, pierced by an array of custom-designed holes and treated with different anodized natural colours protects the windows from the east and west low sun transforming the building in a sort of large tree-trunk with an iridescent bark.

Ref: <http://www.archello.com/en/project/u15-office-building>, (05/2015).

Technological data of the perforated envelope								
Construction & perforation parameters								
Question		**Answer options**						
Q.1	What is the type of intervention of the perforated envelope?	Newly added		Previously built				
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More		

Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope

Passive design parameters

Question		Answer options					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				

Active design parameters

Question		Answer options				
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA		
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA	
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others		
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA		
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA		

Socio-cultural indicators of the perforated envelope

Usability, adaptability, and connectivity

Question		Answer options			
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA	
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA

Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 27: Company Building in Kanagawa

Structured information					
Building location:	Kanazawa-Japan	Architect/s:	HMAA	Site topography:	Flat Land
Construction date/s:	2014	Site context:	Suburban	Climatic zone:	Moderate climate
Building use:	Public / Offices	Users group:	All genders-All ages	Floors number:	3 Floors

Visual information

Ref: <http://www.archello.com/en/project/company-building-kanagawa#>, (02/2015).

Textual information

The first floor in the company building is the inventory storage warehouse, the second floor is for a maximum of 16 person's business space, and the third floor was asked for an executive room and a conference room. Though the building area allowed legally is secured to the utmost, in order to solve the amenity of a business space, and the problem of privacy and the afternoon sun, a spot garden articulated by perforated metal screen was prepared at the corner of the building.

Ref:<http://www.archello.com/en/project/company-building-kanagawa#>, (02/2015).

Technological data of the perforated envelope

Construction & perforation parameters

	Question	Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope

Passive design parameters

	Question	Answer options					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	10:1
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				

Active design parameters

	Question	Answer options				
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA		
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA	
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others		
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA		

Q.36	Are there other used active design techniques/elements?	Yes: specify			No	NA	
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials		NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades		NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades		No	NA
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades		No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades		No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades		No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades		No	
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades		No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades		No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades		No	
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 28: CAP Progres Raval de Badalona

Structured information

Building location:	Badalona-Spain	Architect/s:	Jordi Badia Rodriguez	Site topography:	Flat Land
Construction date/s:	2009-2011	Site context:	Urban	Climatic zone:	Moderate climate
Building use:	Public / Office-medical	Users group:	All genders-All ages	Floors number:	4 Floors

Visual information	Textual information
	The CAP Progrès Raval was built on a gradient of Badalona, on a site where there was an old glass factory and the objective besides providing coverage of commercial and social activity for the neighbourhood environment. The building was integrated into a newly created space, opening a public space that did not exist. The facade is protected by a ceramic insulation lattice that provides the building with the aim of making it more energy efficient. Striking the pillar on the left side of the building, which is the only pillar on which the building rests on that side. The building opens out onto a newly-built square and has a courtyard-style entrance. The new health centre, together with the council buildings, shape a new urban space. The consulting area is a black prism covered with ceramic lattice which is supported from the ground floor. A single, very expressive column separates the entrance courtyard from the remaining public space.
Ref:<http://www.fenster.es/en/project/progres-raval-health-centre/>, (05/2015).	*Ref:<http://www.fenster.es/en/project/progres-raval-health-centre/>, (05/2015).*

Technological data of the perforated envelope

Construction & perforation parameters

	Question	Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Ceramic		
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope

Passive design parameters

	Question	Answer options				
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No		

Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				
	Active design parameters						
	Question	**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			
	Socio-cultural indicators of the perforated envelope						
	Usability, adaptability, and connectivity						
	Question	**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		
	Economic indicators of the perforated envelope						
	Initial costs, running costs, and maintainability						
	Question	**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate	Low	NA		
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		

Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 29: Plescop City Hall

Structured information

Building location:	Plescop-France	Architect/s:	L'hyver-Brechet-Lohé	Site topography:	Flat Land
Construction date/s:	2012	Site context:	Urban	Climatic zone:	Moderate climate
Building use:	Public / City Hall	Users group:	All genders-All ages	Floors number:	3 Floors

Visual information

Ref:<http://www.archiexpo.com/prod/lafarge/product-70029-968178.html>, (01/2015).

Textual information

The architectural firm L'hyver-Brechet-Lohé designed and built an extension to Plescop City Hall in Morbihan. White, reinforced, 50% perforated panels with organic fibbers cover the building, six different panel types up to 5.5 m x 3.9 m x 10 cm thick and covering more than 170 m² of the façade were used in the building façade.

Ref:<http://www.archiexpo.com/prod/lafarge/product-70029-968178.html>, (01/2015).

Technological data of the perforated envelope

Construction & perforation parameters

Question		Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Organic Fibres		
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope							
Passive design parameters							
Question		**Answer options**					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Variant
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				
Active design parameters							
Question		**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate	Low	NA		
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			

Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 30: Extension of City Hall of Illkirch

Structured information

Building location:	Illkirch-France	Architect/s:	Atelier Filippini	Site topography:	Flat Land
Construction date/s:	2014	Site context:	Urban	Climatic zone:	Moderate climate
Building use:	Public / City hall	Users group:	All genders-All ages	Floors number:	1 Floors

Visual information

Ref:<http://aasarchitecture.com/2015/02/city-hall-illkirch-graffenstaden-atelier-filippini.html>, (03/2015).

Textual information

The extension of the city hall aimed to connect three different buildings by adding a new reception structure and by improving the thermal performance and visual aspect of the building envelope, the project creates a new image of the city hall, the glass façades, stainless steel structure and mesh used for connecting elements have been designed as aspects of a new urban landmark that ensures the city is seen in a modern light. Light-emitting diodes can be used in many different configurations, illuminate the glass façade, the stainless steel shell and the water feature, a stainless steel mesh covers all connecting and transitional elements, and is used to protect the lower floor of the glass façade, they create openness and views to and from outdoor areas. The glass façade is set back from the historical façade. Inside, perforations in the shell's envelope filter the light entering the building while still allowing visitors to enjoy views of urban areas. Outside, the shell seems to float on the water that surrounds it. This material does not need any maintenance or further treatment. The new skin is composed of a "breathable" screen-printed glass façade with built-in venetian blinds, air enters vents at the base of the building, special attention has been paid to using environmentally friendly techniques, including double-skin facades to trap pre-heated air and reduce the need for heating in winter and mid-season. Exterior walls are insulated using 20cm of insulating material on vertical surfaces, also high performance double-glazed windows with argon gaps have been used.

Ref:<http://aasarchitecture.com/2015/02/city-hall-illkirch-graffenstaden-atelier-filippini.html>, (03/2015).

Technological data of the perforated envelope

Construction & perforation parameters

Question		Answer options						
Q.1	What is the type of intervention of the perforated envelope?	Newly added		Previously built				
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More		
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None	

Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			
Environmental indicators of the perforated envelope									
Passive design parameters									
Question		**Answer options**							
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others			
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others			
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios			
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No					
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant			
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA				
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA				
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA				
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	15:1		
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA				
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA				
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No						
Active design parameters									
Question		**Answer options**							
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA			
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA					
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA				
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others					
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA					
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA					
Socio-cultural indicators of the perforated envelope									
Usability, adaptability, and connectivity									
Question		**Answer options**							
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA					
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA				
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA				

Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No	
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No	

Economic indicators of the perforated envelope

Initial costs, running costs, and maintainability

Question		Answer options				
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA
Q.49	Does the perforation technique have independent costs?	Yes	No	NA		
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA		
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA	
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA	
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA	
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA	
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA	
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA	
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA	
Q.58	Is the perforated layer easily cleanable?	Yes	No			
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA		
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No			

Case 31: Edogawa Garage Club Renovation

Structured information

Building location:	Tokyo-Japan	Architect/s:	Jun'ichi Ito & Associates	Site topography:	Flat Land
Construction date/s:	2009	Site context:	Suburban	Climatic zone:	Moderate climate
Building use:	Public / Industrial	Users group:	All genders- Young & old	Floors number:	2 Floors

Visual information	Textual information
	Ribbons of wave-like perforated steel form a mask, the second façade of this old warehouse, colour variations highlighted by light changes produce unexpected checkered patterns as well as silver and gold toning enhancing the façade's versatile nature, it is a repair plan of the old warehouse in Tokyo regarding environment by avoiding CO2 discharge called demolition and new building, and reuse the existing building. In order to secure the available light and natural ventilation from a window at the same time it prevents the invader from the outside, the building was covered by the steel plate panel which made the hole and which carried out special processing, strength of structure was secured by attaching checkered unevenness to a panel. Moreover, the building is kept from becoming dirty from one-sheet one panel also inserting in a corner portion, and cutting rain. This design acts sensitively in union natural environment which changes every moment, such as light, air, and begins to make a beautiful expression just like the ripples of a surface of a river.
Ref:<http://www.archdaily.com/267316/edogawa-garage-club-renovation-junichi-ito-architect-associates>, (04/2015)	*Ref:<http://www.archdaily.com/267316/edogawa-garage-club-renovation-junichi-ito-architect-associates>, (04/2015).*

Technological data of the perforated envelope									
Construction & perforation parameters									
Question		**Answer options**							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Wavy	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope							
Passive design parameters							
Question		**Answer options**					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	5:1
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				

Active design parameters						
Question		**Answer options**				
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA		
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA	
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others		
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA		

Q.36	Are there other used active design techniques/elements?	Yes: CO_2 reduction rate			No	NA	
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials		NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades		NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades		No	NA
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades		No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades		No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades		No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades		No	
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades		No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades		No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades		No	
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 32: Incineration Line Building

Structured information					
Building location:	Roskilde-Denmark	Architect/s:	Erick Van Egeraat	Site topography:	Hilly Land
Construction date/s:	2014	Site context:	Suburban	Climatic zone:	Moderate climate
Building use:	Public / Industrial	Users group:	All genders-Young & old	Floors number:	Undetermined

Visual information	Textual information
	The energy tower plant incinerates waste from nine surrounding municipalities and from many places abroad to produce electricity and heat power for the whole region of Roskilde. The façade consists of two layers: the inner layer is the skin which provides the actual climatic barrier, allowing the second skin to be treated more freely raw umber-coloured aluminium plates with an irregular pattern of laser cut circular holes, the aluminium plates are treated to give them the desired colour and patina at day time. At night, the programmable lighting, installed between the two facades, gives the building an additional metaphor. For the illumination of the façade it was important that only the light and not the light sources themselves are visible, this has been realized by reflecting the light on the inner façade, which allowed the light glowing decently through the perforated skin. The design is based on simple construction details combined with cutting edge manufacturing technology for the production of the aluminium façade panels and clever processing and repetition. Due to its large scale, the incinerator is destined to become an outstanding structure in the wide and open landscape of the Roskilde area and represents a hypermodern and sustainable energy plant, where waste will be turned into power. The new incinerator in Roskilde is created specifically to add value to an otherwise purely industrial complex.
Ref: <http://www.archdaily.com/544175/incineration-line-in-roskilde-erick-van-egeraat>, (03/2015).	*Ref: <http://www.archdaily.com/544175/incineration-line-in-roskilde-erick-van-egeraat>, (03/2015).*

Technological data of the perforated envelope

Construction & perforation parameters

	Question	Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	NA	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope

Passive design parameters

Question		Answer options					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Variant
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				

Active design parameters

Question		Answer options				
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA		
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA	
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others		
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA		
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA		

Socio-cultural indicators of the perforated envelope

Usability, adaptability, and connectivity

Question		Answer options				
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA		
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No	
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No	

Economic indicators of the perforated envelope

Initial costs, running costs, and maintainability

Question		Answer options			
Q.48	What is the perforated material's relative initial costs?	High	Moderate	Low	NA
Q.49	Does the perforation technique have independent costs?	Yes	No	NA	

Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 33: Raas Hotel

Structured information

Building location:	Jodhpur-India	Architect/s:	Lotus Praxis Initiative	Site topography:	Mountainous
Construction date/s:	2011-2012	Site context:	Urban	Climatic zone:	Dry arid
Building use:	Public / Recreational	Users group:	All genders-All ages	Floors number:	5 Floors

Visual information / **Textual information**

Ref: http://www.e-architect.co.uk/india/raas-jodhpur-mehrangarh-fort>, (05/2015).

The design is a dialogue between the old and the new, using the same materials and skills as the traditional buildings such as lime mortar and Jodhpur sandstone. Inspired by the age old double skinned structures of the region, the traditional stone latticed forms of Rajasthan architecture, which perform multiple functions of passive cooling and offering privacy to the user, these buildings act as lanterns framing the site. The drama of the stone (lattice) is heightened by the fact that these panels can be folded away by each user to reveal uninterrupted views of the fort, or can be closed for privacy and to keep the harsh Jodhpur sun out. The headboard was made in hand cut perforated stone that was back lit. The air-conditioning system is Variable Refrigerant Volume based, which is amongst the greenest technologies available currently for air conditioning and enjoys a Platinum LEEDS rating.

Ref: http://www.e-architect.co.uk/india/raas-jodhpur-mehrangarh-fort>, (05/2015).

Technological data of the perforated envelope

Construction & perforation parameters

Question		Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				

Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays				
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant	
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant	
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA	
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces		
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA	
Environmental indicators of the perforated envelope							
Passive design parameters							
Question		**Answer options**					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				
Active design parameters							
Question		**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: LEED	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		

Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades		No	

Economic indicators of the perforated envelope

Initial costs, running costs, and maintainability

	Question	Answer options					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 34: Caldor Hotel

Structured information

Building location:	Seedörfl-Austria	Architect/s:	Söhne& Partner Architekten	Site topography:	Flat Land
Construction date/s:	2009	Site context:	Suburban	Climatic zone:	Moderate climate
Building use:	Public /Educational	Users group:	All genders-All ages	Floors number:	2 Floors

Visual information

Ref:<http://www.arthitectural.com/sohne-partner-architekten-caldor-hotel/>, (05/2014).

Textual information

The two-storey folded volume of the building with its projecting snout, bedrooms on the first floor and striking perforated bands along the façade looks like a built logo. The materials are reduced to a minimum, the curtain wall is on hand the protection against weathering for the cross point. On the other hand, it also gives shade and shelter. The perforation of the façade panels plays with the logo of the hotel, abstract its. Spaces inside / outside are created which emphasizes the communication between them. Low building cost where the basis for moderate fees for the rooms.

Ref:<http://www.arthitectural.com/sohne-partner-architekten-caldor-hotel/>, (05/2014).

Technological data of the perforated envelope

Construction & perforation parameters

	Question	Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added		Previously built					
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome		Flat	Inclined	Others	Not perforated		
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks			By drilling the panels				
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	

Q.11	What is the perforation pattern shape?	**Primitive geometries**	Floral	Symbolic	Irregular	Others	
Q.12	What is the perforation approximate sizing?	Very tiny-sized	**Small-sized**	Large-sized	Variant		
Q.13	What is the configuration type of perforation	Regular arrays	**Irregular arrays**				
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	**36-50%**	Over 51%	Variant	
Q.15	What is the approximate thickness of the perforated layer?	**1- 9 mm**	1-5 cm	5-30 cm	Over 30 cm	Variant	
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	**Over 1m**	Variant	NA	
Q.17	Does the perforated layer have open-able elements?	Yes	**No**	Few	Not in all faces		
Q.18	For partial perforations, are there windows beside perforation?	Yes	**No**	Few	Not in all faces	NA	

Environmental indicators of the perforated envelope

Passive design parameters

Question		Answer options					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	**Aesthetic**	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	**Not considered**	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	**11-35%**	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	**Slightly**	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	**Man-made common**	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	**Low**	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	**No**	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	**No**	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	**Variant**
Q.28	What is the level of material's resistance to moisture and rain?	High	**Moderate**	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	**Slightly**	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	**No**				

Active design parameters

Question		Answer options				
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	**NA**
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	**NA**		
Q.33	Does the envelope's design enhance the energy-saving?	Yes	**Slightly**	No	NA	
Q.34	Does the perforation need technology for manufacturing?	**Yes: prefabricated panels**	No: manually created	Others		
Q.35	Does the building have some awards/certificates?	Yes: specify	**No**	NA		
Q.36	Are there other used active design techniques/elements?	Yes: specify	**No**	NA		

Socio-cultural indicators of the perforated envelope

Usability, adaptability, and connectivity

Question		Answer options				
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	**No**	NA		
Q.38	Is the perforated material commonly used by the community?	Yes	**No**	Not all used materials	NA	
Q.39	Is the air cavity accessible for building's occupants?	**Yes**	No	Not in all facades	NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	**Yes**	Slightly	Not in all facades	No	NA
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	**Yes**	Slightly	Not in all facades	No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	**Yes**	Slightly	Not in all facades	No	
Q.43	Does the perforation's configuration increase visual privacy?	**Yes**	Slightly	Not in all facades	No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	**Yes**	Slightly	Not in all facades	No	

Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades		No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades		No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades		No	
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 35: Al-Ghanim Clinic

Structured information					
Building location:	Kuwait	Architect/s:	AGi architects	Site topography:	Flat Land
Construction date/s:	2014	Site context:	Suburban	Climatic zone:	Dry arid
Building use:	Public / Medical	Users group:	All genders-All ages	Floors number:	4 Floors

Visual information	**Textual information**
	Challenging issues such as privacy and security are addressed using a new model in this clinic, where courtyards attached to the façade are the driving element behind the unique typology of the building. The courtyards are carved into the building, allowing for natural light into all the clinics. The concept of the façade generating light, views and ventilation is reversed; and the courtyards are brought inwards from the perimeter creating further privacy. Examination rooms have been located towards the closed outer façade and opened to the interior courtyards in which common space flows. Also the perforation pattern connects to the cultural identity, an anodized and perforated metal sheet allows sufficient light to enter, constructing a veiled threshold in between exterior and internal courtyard.
Ref: <http://www.archdaily.com/611323/ali-mohammed-t-al-ghanim-clinic-agi-architects>, (01/2015).	*Ref: <http://www.archdaily.com/611323/ali-mohammed-t-al-ghanim-clinic-agi-architects>, (01/2015).*

Technological data of the perforated envelope									
Construction & perforation parameters									
Question		**Answer options**							
Q.1	What is the type of intervention of the perforated envelope?	Newly added		Previously built					
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	

Q.6	What is the number of perforated layers in the envelope?	1	2	More				
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated		
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels					
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others		
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant			
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays					
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant		
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant		
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA		
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces			
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA		

Environmental indicators of the perforated envelope

Passive design parameters

	Question	Answer options					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	5:1
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: courtyards	No				

Active design parameters

	Question	Answer options				
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA		
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA	
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others		
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA		
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA		

Socio-cultural indicators of the perforated envelope

Usability, adaptability, and connectivity

	Question	Answer options				
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA		
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA

Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades		No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades		No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades		No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades		No	
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades		No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades		No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades		No	
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 36: Torre de Especialidades Hospital

Structured information					
Building location:	Mexico City-Mexico	Architect/s:	Alison Dring	Site topography:	Flat Land
Construction date/s:	2013	Site context:	Urban	Climatic zone:	Dry semiarid
Building use:	Public / Medical	Users group:	All genders-All ages	Floors number:	7 Floors

Visual information

Ref: <http://www.fastcoexist.com/1681660/this-beautiful-mexico-city-building-eats-the-citys-smog#1>, (05/2015).

Textual information

This building sucks up pollution (smog-eating technology), a titanium dioxide coating on the building materials creates a chemical reaction when it comes into contact with ultraviolet rays and pollutants in the air, a new design material that fights against pollution rather than reducing it. The building provides a green solution to the pollution that characterizes large cities. The treatment is a thin layer of titanium dioxide (TiO_2), a powder or liquid that can be applied to glass, concrete, metal, or fabric; when sunlight hits the chemically treated surface, a process begins that oxidizes organic matter, turning pollutants into water vapour and CO_2. The façade was designed to use a new system of thermoformed plastic shells are coated in TiO_2 developed by Elegant Embellishments. The system blends sustainability with forward-thinking construction techniques and novel form: the developers used Rhino to fabricate five different modules, each shaped to maximize surface area, light reception, and wind resistance, and thus increase the benefits of the treatment. The hospital's bone-like, perforated surfaces are lightweight and easily detachable.

Ref: <http://iqoffice.ca/the-facade-of-the-torre-de-especialidades-in-mexico-city/ >, (05/2015). <http://www.fastcoexist.com/1681660/this-beautiful-mexico-city-building-eats-the-citys-smog#1>, (05/2015).

Technological data of the perforated envelope									
Construction & perforation parameters									
Question		**Answer options**							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Thermoformed plastic + TiO2			
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope						
Passive design parameters						
Question		**Answer options**				
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No		
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA	
Q.25	Does the perforated layer have insulations?	Yes: cavity	No	Not in all facades	NA	
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA	
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	5:1
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA	
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA	
Q.30	Are there other used passive design techniques/elements?	Yes: smog eating material	No			

Active design parameters						
Question		**Answer options**				
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA		
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA	
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others		
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA		

Q.36	Are there other used active design techniques/elements?	Yes: specify		No	NA		
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials		NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades		NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades		No	NA
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades		No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades		No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades		No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades		No	
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades		No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades		No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades		No	
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the peroration technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 37: Khmeresque Temple

Structured information

Building location:	Batambang-Cambodia	Architect/s:	Archium , Kim in-cheurl	Site topography:	Flat Land
Construction date/s:	2014	Site context:	Urban	Climatic zone:	Tropical climate
Building use:	Public / Worship	Users group:	All genders-All ages	Floors number:	1 Floor

Visual information	Textual information
	The temple design was based on Mahayana Buddhism. A place that provides shade is the most suitable place that gathers the people in hot tropical regions, the shade from large roof like parasol will make people gather. Once a space is occupied by a roof, it is enough for minimum elements to make space, if the space is not completely closed, it will be not uncomfortable without artificial air conditioning. Therefore, the main purpose of the temple is religious not residential so it was decided to divide the space between indoor and outdoor loosely. The focus of architecture was how to create expression that is familiar with Cambodian Won Buddhists not convenience for clerics, it was decided only to use local materials in building the temple, this was not only because of financial constraints but also to make the temple look like familiar to local people. The building envelope structure was built from reinforced concrete and the roof was built using steel structure, also the Cambodian brick material was used for the perforated envelope.
Ref: <http://www.divisare.com/projects/276487-ARCHIUM-Khmeresque>, (12/2014).	*Ref: <http://www.divisare.com/projects/276487-ARCHIUM-Khmeresque>, (12/2014).*

Technological data of the perforated envelope

Construction & perforation parameters

Question		Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Brick	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	NA	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope

Passive design parameters

Question		Answer options				
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others

Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				
	Active design parameters						
	Question	**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			
	Socio-cultural indicators of the perforated envelope						
	Usability, adaptability, and connectivity						
	Question	**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		
	Economic indicators of the perforated envelope						
	Initial costs, running costs, and maintainability						
	Question	**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate	Low	NA		
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		

Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 38: KAPSARC Mosque

Structured information

Building location:	Riyadh-KSA	Architect/s:	HOK	Site topography:	Flat Land
Construction date/s:	2014	Site context:	Urban	Climatic zone:	Dry arid
Building use:	Public / Worship	Users group:	All genders-All ages	Floors number:	2 Floors

Visual information

Ref:<http://www.archdaily.com/614616/kapsarc-mosque-hok>, (04/2015).

Textual information

The spiritual centre of the King Abdullah Petroleum Studies and Research Centre (KAPSARC) community is a mosque within the linear park at the heart of the site. Highly visible throughout the community, the sanctuary is approached through outdoor courtyards aligned with Mecca and Al Kaaba, the most sacred places in Islam. The prayer hall is set within a reflecting pool and reached from elevated glass bridges leading to its entrances. This procession represents the transition of leaving the profane world to enter the sacred realm. The reflecting pool glows at night, giving the illusion that the entire building is floating over water. To either side of the prayer hall, curving walls screen supporting functions, including ablution spaces and Imam's office. The main prayer hall is designed as a 75-foot-square cube sheathed in a dynamic, layered skin. The outermost layer of glass is separated from an inner layer of stone-clad concrete by three feet. The 115-foot-tall minaret is designed to complement the mosque in its similar patterns of stone cladding and windows. The exteriors of both structures are designed to represent an abstracted version of a traditional Arabic pattern and create an ever-changing experience of light and shadow. During the day, the play of shadows from the complex mullion patterns on the glass travel over the inner stone façade. Similar contrasts of light and shade animate the mosque interior over the course of a day. At night, the glass box becomes a lantern in the landscape, punctuated with points of light. Custom, square pendants arranged in a grid pattern and suspended by cables illuminate the interior. The main prayer hall accommodates 200 men, while a mezzanine level accommodates 100 women. Wrapping its walls and ceiling is a modern interpretation of an Arabic screen wall (Mashrabiya) that glows with natural light from windows and skylights to brighten the modern space. Overlapping shapes enliven the walls, while the ceiling presents a more traditional design.

Ref:<http://www.archdaily.com/614616/kapsarc-mosque-hok>, (04/2015).

Technological data of the perforated envelope

Construction & perforation parameters

Question		Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	

Q.6	What is the number of perforated layers in the envelope?	1	2	More				
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated		
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Stone + Concrete	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels					
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others		
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant			
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays					
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant		
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant		
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA		
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces			
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA		

Environmental indicators of the perforated envelope

Passive design parameters

	Question	Answer options					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Variant
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				

Active design parameters

	Question	Answer options				
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA		
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA	
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others		
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA		
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA		

Socio-cultural indicators of the perforated envelope

Usability, adaptability, and connectivity

	Question	Answer options				
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA		
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA

Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades		No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades		No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades		No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades		No	
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades		No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades		No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades		No	
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 39: Step Up 5th Centre

Structured information

Building location:	Santa Monica-USA	Architect/s:	Brooks & Scarpa	Site topography:	Flat Land
Construction date/s:	2009	Site context:	Urban	Climatic zone:	Dry arid
Building use:	Public / Community	Users group:	All genders-All ages	Floors number:	5 Floors

Visual information

Ref: <http://archinect.com/firms/project/387/step-up-on-fifth/4163252>, (03/2015).

Textual information

The new building provides a home and services for the homeless and mentally disabled population. Aluminium panels were used on the main façade creates a dramatic screen that sparkles in the sun and glows at night, while also acting as sun protection and privacy screens. South-facing walls filter direct sunlight with asymmetrical horizontal openings that lend unexpected visual depth while creating a sense of security for the emotionally sensitive occupants, the small-scale elements on the façade enhance the existing streetscape and promote a lively pedestrian environment. The design strategies include: locating and orienting the building to control solar cooling loads; shaping and orienting the building for exposure to prevailing winds; shaping the building to induce buoyancy for natural ventilation; designing windows to maximize day lighting; shading south facing windows and minimizing west-facing glazing; designing windows to maximize natural ventilation; utilizing low flow fixtures and storm water management; shaping and planning the interior to enhance daylight and natural air flow distribution. These passive strategies alone make this building 50% more efficient than a conventionally designed structure. The project uses compact fluorescent lighting throughout the building and double-pane windows that have a low-E coating, and the project has followed the LEED certification process.

Ref: <http://archinect.com/firms/project/387/step-up-on-fifth/4163252>, (03/2015).

Technological data of the perforated envelope

Construction & perforation parameters

Question		Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope							
Passive design parameters							
	Question	**Answer options**					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	15:1
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: several techniques	No				
Active design parameters							
	Question	**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: LEED	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
	Question	**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
	Question	**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate	Low	NA		
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			

Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 40: Community Centre, Seden

Structured information

Building location:	Sedan-France	Architect/s:	Philippe Gibert	Site topography:	Flat Land
Construction date/s:	2009	Site context:	Suburban	Climatic zone:	Moderate climate
Building use:	Public / Community	Users group:	All genders-All ages	Floors number:	1 Floors

Visual information

Ref: <http://www.archi-guide.com/PH/FRA/ChM/SedanMaiQuartCGeorginGi.jpg>, (04/2015).

Textual information

In this community centre, the façade was covered with perforated panels with organic fibres, allowing freedom from the limitations of natural lighting and glazing protection. Each panel, with about 300 round perforations, therefore functions as a shade screen by filtering the sunlight. Grey-blue in colour, the perforated panels produce a subtle light and shadow effect inside during the day, and outside at night as well, due to the floodlight installed between the panels and glazing.

Ref: <http://www.archello.com/en/project/cultural-centre-sedan>, (03/2015).

Technological data of the perforated envelope

Construction & perforation parameters

	Question	Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Organic fibres		
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			

Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant	
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA	
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces		
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA	
Environmental indicators of the perforated envelope							
Passive design parameters							
Question		**Answer options**					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				
Active design parameters							
Question		**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		

Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 41: Childcare Centre, *nursery and communal premises*

Structured information

Building location:	Tourrette Levens-FR	Architect/s:	Heams & Michel	Site topography:	Mountainous
Construction date/s:	2013	Site context:	Rural	Climatic zone:	Moderate climate
Building use:	Public / Community	Users group:	All genders-All ages	Floors number:	2 Floors

Visual information

Ref: <http://www.e-architect.co.uk/france/tourrette-levens-childcare-center>, (04/2015).

Textual information

The new building includes a family day care of three units with a kitchen and communal facilities. The topography has two different slopes: a steep slope to the wild vegetation in the upper part and a false-flat shape parking at its lower end. It is bounded above by a road that overhang it and below by a path. The communal spaces are distributed from the level of the road and open fully to an outdoor public space. Cantilevered over the ground floor, the volume of the room stands out for its material and its mouldings. The roof planted and cut by three colourful patios becomes a natural extension of the surrounding landscape. The façade with opaque print is covered with a skin of perforated concrete that lets in natural light coming from the outside.

Ref: <http://www.e-architect.co.uk/france/tourrette-levens-childcare-center>, (04/2015).

Technological data of the perforated envelope									
Construction & perforation parameters									
Question		**Answer options**							
Q.1	What is the type of intervention of the perforated envelope?	Newly added		Previously built					
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						

Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others		
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant			
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays					
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant		
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant		
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA		
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces			
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA		
Environmental indicators of the perforated envelope								
Passive design parameters								
Question		**Answer options**						
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others		
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others		
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios		
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No				
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant		
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA			
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA			
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA			
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	20:1	
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA			
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA			
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No					
Active design parameters								
Question		**Answer options**						
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA		
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA				
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA			
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others				
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA				
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA				
Socio-cultural indicators of the perforated envelope								
Usability, adaptability, and connectivity								
Question		**Answer options**						
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA				
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA			
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA			
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA		
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA		
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No			
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No			

Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No	
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No	
Economic indicators of the perforated envelope						
Initial costs, running costs, and maintainability						
Question		**Answer options**				
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA
Q.49	Does the perforation technique have independent costs?	Yes	No	NA		
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA		
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA	
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA	
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA	
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA	
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA	
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA	
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA	
Q.58	Is the perforated layer easily cleanable?	Yes	No			
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA		
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No			

Case 42: Mashrabiya House - Jerusalem

Structured information

Building location:	Jerusalem-Palestine	Architect/s:	Senan Abdelqader	Site topography:	Hilly
Construction date/s:	2011	Site context:	Suburban	Climatic zone:	Moderate climate
Building use:	Residential	Users group:	All genders-All ages	Floors number:	4 Floors

Visual information

Ref: <http://www.arthitectural.com/senan-abdelqader-the-mashrabiya-house/>,(01/2015).

Textual information

The house is a contemporary re-interpretation of Arab vernacular architecture, providing new solutions for the transforming social and cultural landscape. The floating effect is achieved through the creative interpretation of an Arab “Mashrabiya”. Here, the wooden screen is re-imagined in the form of a large-scale stone envelop that surrounds the building, combining the “Mashrabiya” motif with stone. It’s typical semi-transparent effect is achieved by positioning the stones slightly apart, with irregular spacing, creating an effect of lightness and porosity. The resulting stone envelop is structurally separated by a narrow gap from the actual apartment building behind. The playful arrangement of small and large openings provides views from the interiors out into the landscape while carefully retaining their privacy. Beyond the formal references to Arab vernacular traditions, the building developed and tested concepts that could help to inform an agenda of sustainability while maintaining historical cultural continuity: In this way the “Mashrabiya” is not only a traditional threshold between public and private space but also provides an element of climatic control. The stone mass of the outer envelope acts as a climatic buffer to absorb heat during the day and release heat during the cool Jerusalem nights. Thus it protects the building against solar radiation as well as winter rain and winds. The gaps between the stones ensure a constant flow of fresh air. A further element of passive cooling is the 1m gap between outer and inner envelop. Not only does it ensure constant circulation of fresh air around the building, the fact that it remains open towards the top of the building to generate a suction effect like that of a chimney: Hot air travels upwards and fresh air is sucked into the gap from below.

Ref: <http://www.arthitectural.com/senan-abdelqader-the-mashrabiya-house/>,(01/2015).

Technological data of the perforated envelope

Construction & perforation parameters

Question		Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			

Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA	
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces		
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA	
Environmental indicators of the perforated envelope							
Passive design parameters							
Question		**Answer options**					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: solar chimney	No				
Active design parameters							
Question		**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		
Economic indicators of the perforated envelope							

Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 43: Masdar City Residences

Structured information

Building location:	Masdar-UAE	Architect/s:	Foster & Partners	Site topography:	Flat Land
Construction date/s:	2006-2025	Site context:	Urban	Climatic zone:	Dry arid
Building use:	Residential	Users group:	All genders-All ages	Floors number:	4 Floors

Visual information

Ref: <http://www.designboom.com/architecture/foster-partners-masdar-institute-campus/>, (12/2014).

Textual information

Masdar city exists as an urban development project run by the renewable energy company Masdar, the city has a wealth of potential to offer a green urban planning – something the world sorely needs, it was initiated in 2006 to become the world's first zero carbon city run using solar and other renewable energy sources, and generating zero waste. The original construction duration was to be 8 years but with the financial crisis the project has slowed down and is estimated to be complete by 2025. The city was planned to fit the sustainable principles underpinning the overall master plan, the buildings have self-shading facades and are orientated to provide maximum shade as well as sheltering adjacent buildings and the pedestrian streets below, buildings at Masdar incorporate numerous material and construction strategies for minimizing heat gain including metal screening, terracotta cladding and air-filled wall panels. Over 5,000 square meters of roof mounted photovoltaic installations provide power and additional shading at street level. Windows in the residential buildings are protected by a contemporary reinterpretation of "Mashrabiya", a type of latticed projecting oriels window, constructed with sustainably developed, glass-reinforced concrete, coloured with local sand to integrate with its desert context and to minimize maintenance. The perforations for light and shade are based on the patterns found in the traditional Islamic architecture. Horizontal, vertical fins, and solar shades to cover the residential units, these are highly insulated by facades of inflatable cushions, which remain cool to the touch under the most intense desert sun. Cooling air currents are channelled through the public spaces using a contemporary interpretation of the region's traditional wind-towers. The public spaces are further cooled by green landscaping and water to provide evaporative cooling.

Ref: <http://www.dexigner.com/news/21975>, (12/2014).

Technological data of the perforated envelope

Construction & perforation parameters

Question		Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Terracotta		
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Glass	Terracotta		
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope

Passive design parameters

Question		Answer options					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: several	No				

Active design parameters

Question		Answer options				
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA		
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA	
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others		
Q.35	Does the building have some awards/certificates?	Yes: LEED	No	NA		

Q.36	Are there other used active design techniques/elements?	Yes: specify			No	NA	
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials		NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades		NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades		No	NA
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades		No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades		No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades		No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades		No	
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades		No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades		No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades		No	
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 44: 28th Street YMCA Apartments Extension

Structured information

Building location:	Los Angeles-USA	Architect/s:	Koning Eizenberg, KEA	Site topography:	Flat Land
Construction date/s:	2012	Site context:	Urban	Climatic zone:	Dry Arid
Building use:	Residential	Users group:	All genders-All ages	Floors number:	5 Floors

Visual information

Ref: <http://inhabitat.com/affordable-solar-powered-28th-street-apartments-revive-historic-1926-building-in-los-angeles/>, (06/2015).

Textual information

The project provides housing to the homeless, individuals transitioning from foster care and adults with mental illness. The project adds new residential units, upgrades existing units and revitalizes principal spaces and features of a historic YMCA. Twenty-five new residential units are added in a thin five story stucco-clad building that abuts the existing building at the rear of the lot. Solar hot water panels cover the roof and PV's shade and generate power on the south façade leaving the historic building free of attachments and uncompromised. Lightweight perforated metal screens wrap the walkway and stairs of the addition facing the historic building to contrast with the original architecture and highlight its weight and solidity. The screens feather at the corners to reveal views of the city and some perforations are tabbed rather than punched through to create a secondary ephemeral pattern. The pattern, abstracted from reliefs on the historic building, appears and disappears depending on the angle of the light incorporating the historic ornament that the community clearly loved. The architect was able to knit together historical continuity and something very new, something of high architectural value, in addition to the approach released the roof for use as an elevated garden to provide an anchoring social space to link old and new.

Ref: <http://www.detail-online.com/architecture/topics/28th-street-apartments-in-los-angeles-022085.html>, (06/2015).

Technological data of the perforated envelope

Construction & perforation parameters

Question		Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope

Passive design parameters

Question		Answer options					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	50:1
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				

Active design parameters

Question		Answer options					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: LEED	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: several	No	NA			

Socio-cultural indicators of the perforated envelope

Usability, adaptability, and connectivity

Question		Answer options				
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA		
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No	
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No	

Economic indicators of the perforated envelope

Initial costs, running costs, and maintainability

Question		Answer options			
Q.48	What is the perforated material's relative initial costs?	High	Moderate	Low	NA
Q.49	Does the perforation technique have independent costs?	Yes	No	NA	

Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 45: House (Abbink X de Haas)

Structured information					
Building location:	Amsterdam-Neth.	Architect/s:	Chris Kabel	Site topography:	Flat Land
Construction date/s:	2007-2012	Site context:	Urban	Climatic zone:	Moderate climate
Building use:	Residential	Users group:	All genders-All ages	Floors number:	3 Floors

Visual information	Textual information
 	In the centre of the old city, Chris Kabel has wrapped this house and studio with a facade of perforated hexagons that catches the light like a hanging sheet of fabric. Kabel was approached by architecture studio Abbink X de Haas to collaborate on a building exterior that would relate to the history of the area, which is within the city's red light district but is also associated with the textile industry. This was the area where wool and cloth were dyed in the sixteenth and seventeenth century, in fact one of Rembrandt's paintings depicts the people that worked here. After considering a series of laser-cut screens, Kabel instead decided to use sheets of aluminium with perforated sections, with these industrially produced aluminium plates the person can punch out a shape, then afterwards he can still bend the perforations, so then it can either catch light or cast a shadow, if they are bent upwards they reflect the light and bending downwards they become darker pixels. By using this technique, the designer was able to replicate a pixilated image of a curtain by twisting over a million of the perforated hexagons using a custom-made tool. On the back of the panel there was either a mark or not a mark, if there was a mark a person had to bend it upwards and if not then he bends it downwards, so actually everything was completely pre-determined, in this way intricate graphics can be applied onto the building using cheaply produced perforated panels without the use of expensive laser cutting. Each aluminium sheet (1000 / 1150 cm) is also powder-coated to keep the facade white, it had to be white because in Amsterdam all of the houses from the canals were always painted white to get as much light as possible into the inner courts. The textured panels cover the entire wall and even form shutters over the windows and doors, the building looks exactly the same as a punched paper.
Ref: <http://www.dezeen.com/2012/11/13/bent-perforated-facade-by-chris-kabel/>, (02/2015).	*Ref: <http://www.dezeen.com/2012/11/13/bent-perforated-facade-by-chris-kabel/>, (02/2015).*

Technological data of the perforated envelope						
Construction & perforation parameters						
Question		Answer options				
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built			

Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			
Environmental indicators of the perforated envelope									
Passive design parameters									
Question		**Answer options**							
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others			
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others			
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios			
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No					
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant			
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA				
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA				
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA				
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others		
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA				
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA				
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No						
Active design parameters									
Question		**Answer options**							
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA			
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA					
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA				
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others					
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA					
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA					
Socio-cultural indicators of the perforated envelope									
Usability, adaptability, and connectivity									
Question		**Answer options**							
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA					

Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No	
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No	

Economic indicators of the perforated envelope

Initial costs, running costs, and maintainability

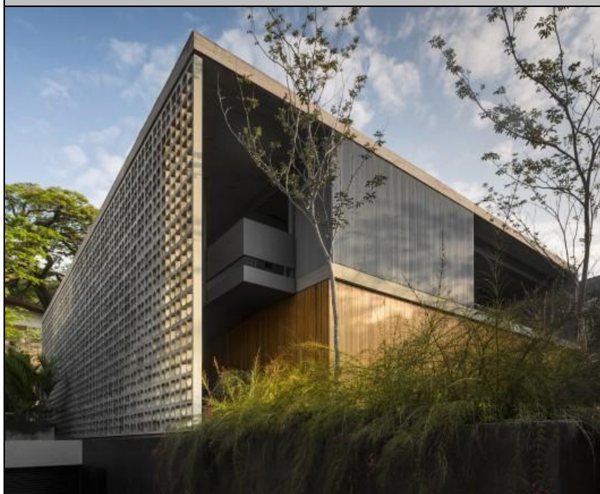
Question		Answer options					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

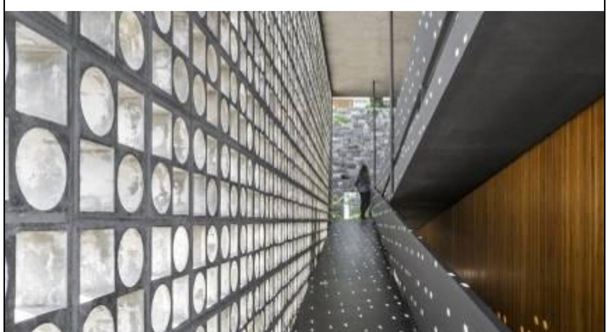
Case 46: B+B House

Structured information

Building location:	Sao Paulo-Brazil	Architect/s:	Studio MK27& Galeria	Site topography:	Hilly Land
Construction date/s:	2014	Site context:	Suburban	Climatic zone:	Moderate climate
Building use:	Residential	Users group:	All genders-All ages	Floors number:	3 Floors

Visual information





Ref: <http://www.archdaily.com/575463/b-b-house-studio-mk27>, (01/2015).

Textual information

The eastern side space is protected by hollowed-out concrete elements to the side, which create surprising effects of light and end up functioning as protection from bad weather conditions. It is an interstitial space between the protected inside of the construction and the open garden. The ramp, long and smooth, extends the transition from interior to exterior creating the constant sensation of environment changing. This solution was vastly used by Brazilian modernism, which consecrated the radical use of ramps as a way of vertical circulation while reaffirming the Corbusier precepts of architectural promenade. There is an intentional uncertainty about the character of this space: internal or external. The reference to modernism lies also in the wall of hollowed-out elements, renowned from the 30's in Brazil, as a solution to be reproduced on large scale, very appropriate for the tropical climate since it allows for shading without blocking of the fresh breeze. The social area of the house creates a sensation of cosiness and comfort, in an open space, without any structural interference for the organization of the furniture layout. A 3.5m sliding door allows the kitchen to be completely integrated to the dining room, the counter used for food preparation is behind the window overlooking the ramp and receiving the 'constructed' light, filtered by the hollowed-out elements, thus the kitchen becomes a lit-up space and a pleasant ambient. Different than the usual solution, the rooms are on the first floor – in direct relation to the garden – and can be also accessed internally via a staircase connected to the living room on the top floor, the wooden elements on this floor's facade allow for the internal control of the sunlight and thus provides for a great thermal performance, the use of 'raw' materials such as exposed concrete and wood give a lively aspect to residence, constantly changing over time.

Ref: <http://www.archdaily.com/575463/b-b-house-studio-mk27>, (01/2015).

Technological data of the perforated envelope

Construction & perforation parameters

Question		Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			

Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant	
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA	
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces		
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA	
Environmental indicators of the perforated envelope							
Passive design parameters							
Question		**Answer options**					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				
Active design parameters							
Question		**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		

Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		Answer options					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 47: Villa Kavel 01

Structured information					
Building location:	Amsterdam-Nether.	Architect/s:	Studio nine dots	Site topography:	Flat Land
Construction date/s:	2014	Site context:	Suburban	Climatic zone:	Moderate climate
Building use:	Residential	Users group:	All genders-All ages	Floors number:	3 Floors

Visual information

Ref:<http://www.archdaily.com/492856/villa-javel-01-studioninedots>, (04/2015).

Textual information

The house that was built with dynamic spatial and material qualities: from an unlimited space with panoramic views of nature to private rooms hidden behind a veil of shutters, from sleek custom furniture against a raw concrete structure to warm timber paired with cold steel. Light and views were key elements of this design. On the north side, the volume is pushed towards the tip of the island thereby extending the south-west elevation; this maximizes sun into the house and views over the park emphasizing the relationship between inside and outside. As the glazing on the facade moves inwards from the western corner, this accentuates the feeling of openness on the ground floor. At the same time, this creates a covered terrace, which is protected from the wind. Along the south facade, the ground is carved out to permit sunlight into the basement; from below, this opens up views over the garden. In contrast with the openness of the living room on the ground floor, the first floor feels intentionally more closed and private. The three bedrooms are wrapped behind black veils made from 33 shutters of perforated steel, lively shadow patterns are cast by the sun on the floors and walls while the shutters unfold like harmonicas with the push of a button – then Voilà, the balconies magically appear. Although Kavel 01 is very defined in shape the building itself offers a wealth of spatial qualities. With its sharp angles and high elevations, the building's appearance changes as you walk around it, from slim and slender to wide and robust. Inside, the atmosphere varies between light and airy to dark and intimate as in a nightclub. The sprayed-concrete facade and steel shutters were specially developed for this project as well as the illuminated black intercom column beside the entrance that resembles a miniature version of the house. This has not only given us immense design pleasure but has also resulted in a sleek and unified aesthetic that evokes a sense of calm and serenity.

Ref:<http://www.archdaily.com/492856/villa-javel-01-studioninedots>, (04/2015).

Technological data of the perforated envelope						
Construction & perforation parameters						
Question		Answer options				
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built			

Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			
Environmental indicators of the perforated envelope									
Passive design parameters									
Question		**Answer options**							
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others			
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others			
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios			
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No					
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant			
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA				
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA				
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA				
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	10:1		
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA				
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA				
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No						
Active design parameters									
Question		**Answer options**							
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA			
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA					
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA				
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others					
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA					
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA					
Socio-cultural indicators of the perforated envelope									
Usability, adaptability, and connectivity									
Question		**Answer options**							
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA					

Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials		NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades		NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades		No	NA
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades		No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades		No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades		No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades		No	
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades		No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades		No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades		No	
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 48: Rue des Suisses Apartment Buildings

Structured information

Building location:	Paris-France	Architect/s:	Herzog & de Meuron	Site topography:	Flat Land
Construction date/s:	2012	Site context:	Urban	Climatic zone:	Moderate climate
Building use:	Residential	Users group:	All genders-All ages	Floors number:	7 Floors

Visual information

Ref:<https://tylerapolich.wordpress.com/?s=Rue+des+Suisses+Apartment>, (12/2014).

Textual information

The "Rue de Suisses" housing project accomplishes an array of dark metal screens are held in front of the apartment balconies via a network of operable bi-fold panels, as inhabitants open and close the screen system, the building reads as a patchwork of dark metal and darker cavernous apertures. The buildings façades have horizontal metal armatures to support an open-able shading system or wire-guided scrims to allow effective water run-off, the scrims overlap where they meet at each floor plate. While this system is not innovative in its operation and effects, the metal armatures are projected at varying distances from the curtain wall system. This introduces a degree of flexibility and diversity in the appearance of the built form. The dark mass of the building projects an aesthetic function, the complex operates as a low-income public housing project, wooden screens on curved tracks became the balcony shades that faced the courtyard, suggesting a greater degree of warmth on the private face than the harsh, seemingly impenetrable, public façade. The building in fact is tragically skin deep; there appears to be an unfortunate degree of dissatisfaction with to function of the facility as a public housing project due to lacking interior architecture quality, the "Rue de Suisses" apartments were uncomfortably detached from their context.

Ref:<https://tylerapolich.wordpress.com/?s=Rue+des+Suisses+Apartment>, (12/2014).

Technological data of the perforated envelope

Construction & perforation parameters

Question		Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	**Previously built**						
Q.2	What is the number of the perforated facades/faces?	**1 face**	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	**1 face**	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	**SW**	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	**Folded**	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	**1**	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	**Not perforated**			
Q.8	What is the type of perforated material?	Wood	Concrete	**Metal**	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	**By drilling the panels**						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	**Glass**	Others	
Q.11	What is the perforation pattern shape?	**Primitive geometries**	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	**Very tiny-sized**	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	**Regular arrays**	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	**11-35%**	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	**1- 9 mm**	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	**Over 1m**	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	**Yes**	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	**NA**			

Environmental indicators of the perforated envelope							
Passive design parameters							
Question		**Answer options**					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	5:1
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				
Active design parameters							
Question		**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate	Low	NA		
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			

Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 49: House in Cape Town

Structured information

Building location:	Cape Town-S. Africa	Architect/s:	Coelacanth K&H	Site topography:	Flat Land
Construction date/s:	2014	Site context:	Urban	Climatic zone:	Moderate climate
Building use:	Residential	Users group:	All genders-All ages	Floors number:	4 Floors

Visual information	Textual information
 	The house was designed for a young family, the resultant form is a minimal white box containing the bedroom accommodation on the first floor, hovering over the living spaces on the ground floor below. This box was articulated with strategic openings maximizing views and exposure to light, with a central courtyard carved out adjacent to the kitchen and dining room to create a focal point. The mass of the floating box is broken down on the street façade with a dramatic screen wall which creates an open-air terrace for the guest wing of the house. The screen offers privacy from the street while allowing views and light to permeate and is constructed from standard pre-cast concrete breeze blocks reminiscent of a bygone era. A hand selected tree was planted in the courtyard as a focal element to provide a shaded garden area that fills the adjacent spaces with dappled light. The tree acts as a natural screen to the direct north light and its canopy creates privacy for the first floor from neighbours. The steel and timber stair connects the two levels and arrives in a large open plan utility space on the first floor which separates the guest wing from the master suite and maintains connections to the courtyard and tree below. Circulation spaces were minimized and were all arranged with external views on axis. A simple pallet of materials allows space, light and volume to take preference over decorative finishes and elaboration. Rough off-shutter concrete elements were used on the street boundary and the courtyard façade accentuating the white box through textural contrast.
Ref:<http://aasarchitecture.com/2015/02/residence-in-cape-town-by-three14-architects.html>, (05/2015).	*Ref:<http://aasarchitecture.com/2015/02/residence-in-cape-town-by-three14-architects.html>, (05/2015).*

Technological data of the perforated envelope

Construction & perforation parameters

Question		Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	

Q.6	What is the number of perforated layers in the envelope?	1	2	More				
Q.7	What is the type of roof perforation?	Perforated dome		Flat	Inclined	Others	Not perforated	
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others
Q.9	How was the perforation created?	By interlocking of blocks			By drilling the panels			
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others
Q.11	What is the perforation pattern shape?	Primitive geometries		Floral	Symbolic	Irregular	Others	
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant			
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays					
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant		
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant		
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA		
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces			
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA		
Environmental indicators of the perforated envelope								
Passive design parameters								
Question		**Answer options**						
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others		
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others		
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios		
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No				
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant		
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA			
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA			
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA			
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others	
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA			
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA			
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No					
Active design parameters								
Question		**Answer options**						
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA		
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA				
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA			
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others				
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA				
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA				
Socio-cultural indicators of the perforated envelope								
Usability, adaptability, and connectivity								
Question		**Answer options**						
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA				
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA			
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA			
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA		

Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 50: Stereoscopic House

Structured information					
Building location:	Singapore	Architect/s:	Pencil Office	Site topography:	Flat Land
Construction date/s:	2012	Site context:	Suburban	Climatic zone:	Tropical
Building use:	Residential	Users group:	All genders-All ages	Floors number:	3 Floors

Visual information	Textual information
 	The design strategies of the house produced a series of passive techniques. The house is sandwiched between a natural ocean view, an artificial golf course view and two neighbouring units two meters left and right. A dramatic combination of overhanging volume and structure reconfigure the relationship between environment, landscape, and view. A distorted tube containing bedrooms on the upper floors isolate three sisters from the adjacent neighbours, while framing dramatic views to ocean and golf course in a stereoscopic relationship. The roof-pitch codes deform the tube; creating a formal approach of deep angular overhangs and striking verandas, reducing insulation on the exterior courtyard, terrace, and living spaces. The angular roof-pitch helps to further frame a picturesque view to neighbouring islands on the third storey terrace. Water jet cut operable shades and an ironwood timber wrapper per formatively lowers heat gain while giving a dramatic elevation. An additional layer of timber cladding is added to the roof, accommodating angular dimensions as well as minimizing heat transfer through the 'kalzip' roof and into interior spaces below. The diffused and reflected sunlight brightens interior spaces in the house through the use of screens attached to angular skylights sited on the roof and windows subtracted from the facades. Together, these additions and subtractions of volumes not only facilitate natural day lighting, but also create a phenomenological experience of light and shadow. The Low-E glazing, solar hot-water heating, extensive cross ventilation, rain harvesting systems, and evaporative cooling are combined with the typology of the colonial veranda.
Ref: <http://www.archdaily.com/432050/stereoscopic-house-pencil-office>, (05/2015).	*Ref: <http://www.archdaily.com/432050/stereoscopic-house-pencil-office>, (05/2015).*

Technological data of the perforated envelope

Construction & perforation parameters

	Question	Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			

Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces		
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA	
Environmental indicators of the perforated envelope							
Passive design parameters							
Question		**Answer options**					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Variant
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: wind catchers	No				
Active design parameters							
Question		**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		

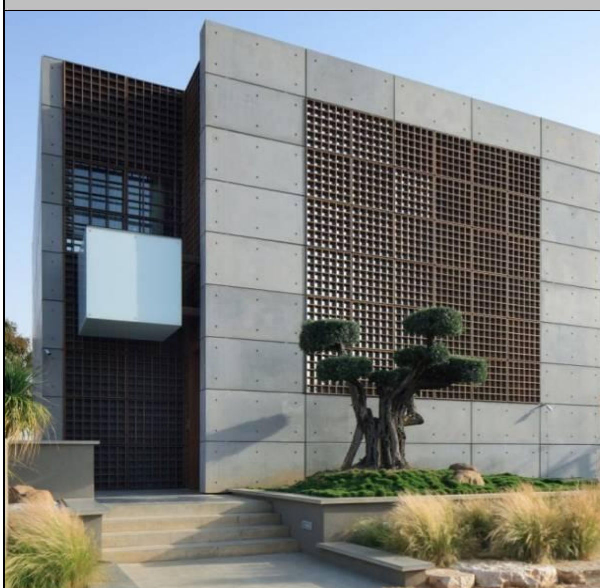
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material’s relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building’s running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope’s design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 51: House K

Structured information

Building location:	Palestine	Architect/s:	Auerbach Halevy	Site topography:	Flat Land
Construction date/s:	2012	Site context:	Rural	Climatic zone:	Moderate climate
Building use:	Residential	Users group:	All genders-All ages	Floors number:	2 Floors

Visual information



Ref: <http://www.contemporist.com/2012/09/25/house-k-by-auerbach-halevy-architects/>, (04/2015).

Textual information

The design is a concrete block, 9 meters height without visible openings, the north elevation facing the street and both side facades seem completely opaque and yet they are not alienated to their environment. The entire structure is covered with a uniform system of prefabricated exposed concrete panels, which are integrated with heavy wood latticework as a reminder to the traditional Arab-Islamic element “Mashrabiya”. The combination of materials and distribution arrangements add warmth, and ease the rigid system. In House K the pre-cast concrete panels participate in the interior design, dictate the rhythm in the house and affect its scale. The same system of dimensions was used by the architect in the exterior dismantle of the cube mass, and for the interior of the house, as a guide for furniture layout and decorative objects. The appearance of the house, therefore, expresses locality, although it relies on seemingly contradictory sources, combining the exposed concrete elements with the trellis wooden work, creates a unified and coherent language, and produces complexity. This combination of elements transcends beyond the contrasting and complementary nature of the materials, resolves the symbolic collision produced by the components, and therefore creating a unity between tradition Arab-Islamic style and modern building.

Ref: <http://www.contemporist.com/2012/09/25/house-k-by-auerbach-halevy-architects/>, (04/2015).

Technological data of the perforated envelope								
Construction & perforation parameters								
Question		**Answer options**						
Q.1	What is the type of intervention of the perforated envelope?	Newly added		Previously built				
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More		
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None	

Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			
Environmental indicators of the perforated envelope									
Passive design parameters									
Question		**Answer options**							
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others			
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others			
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios			
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No					
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant			
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA				
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA				
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA				
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others		
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA				
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA				
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No						
Active design parameters									
Question		**Answer options**							
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA			
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA					
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA				
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others					
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA					
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA					
Socio-cultural indicators of the perforated envelope									
Usability, adaptability, and connectivity									
Question		**Answer options**							
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA					
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA				
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA				

Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades		No	NA
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades		No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades		No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades		No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades		No	
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades		No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades		No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades		No	
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 52: Termitary House - Celosía de ladrillo

Structured information

Building location:	Da Nang-Vietnam	Architect/s:	Marta Mompó García	Site topography:	Flat Land
Construction date/s:	2014-2015	Site context:	Urban	Climatic zone:	Tropical
Building use:	Residential	Users group:	All genders-All ages	Floors number:	2 Floors

Visual information

Ref: <http://www.arquitecturayempresa.es/noticia/celosia-de-ladrillo-termitary-house>, (03/2015).

Textual information

This house was built with extreme climate varies significantly between the season of sun and rain, with involvement of large number of tropical storms per year. Architects were inspired by the ability of termites to build their nests in the local area. The design is open and continuous, and the construction is made of baked bricks, traditional material in the area, which makes the house cool in summer. Double brick skin is available in the wrapper sunscreens are drawn and inside the holes, the slabs are reinforced concrete that is seen, terrazzo floors are coated with dark colours. The lattice brick in the front and rear facades allows light and air to reach every corner of the house and create different light shades throughout the day. In the outer skin of a composition flown side shading facade bricks is arranged and a light-shade that energizes vibration occurs, at night the house transforms into a giant lantern lighting perforations. The patio and garden are covered with coarse gravel, were preserved some of the plants of the old house, for owners to identify themselves with them.

Ref: <http://www.arquitecturayempresa.es/noticia/celosia-de-ladrillo-termitary-house>, (03/2015).

Technological data of the perforated envelope									
Construction & perforation parameters									
Question		Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Brick	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	NA	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope							
Passive design parameters							
Question		Answer options					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No				

Active design parameters						
Question		Answer options				
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA		
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA	
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others		
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA		

Q.36	Are there other used active design techniques/elements?	Yes: specify		No	NA		
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 53: Agbaria House

Structured information

Building location:	Haifa-Palestine	Architect/s:	Ron Fleisher Architects	Site topography:	Flat Land
Construction date/s:	2011	Site context:	Rural	Climatic zone:	Moderate climate
Building use:	Residential	Users group:	All genders-All ages	Floors number:	2 Floors

Visual information	Textual information
	The architect has designed a house in a Palestinian village combining traditional Islamic architecture with modernism, the facade features “Mashrabiya” lattice screens and vents at the top of the house allowing breeze to circulate, the entrance glass wall facing south is shaded with an interpretation of a “Mashrabiya”. The house is entered through a double-height vaulted entrance hall, based on a traditional “Liwan”, around which the private areas of the house are arranged. The “Liwan” is ventilated with passive suction through shutters located on top of 3 vaults 8 meters high. The hot air is sucked out and replaced by a cool breeze. The main drawing room and the formal dining room open to a walled garden, colourfully framed by the white volumes. The landscape slope was divided with traditional terraces made from local stone collected from the families olive groves, it reflects the will to keep an independent Palestinian identity.
Ref: <http://www.dezeen.com/2011/07/01/agbaria-house-by-ron-fleisher-architects/>, (03/2015).	*Ref: <http://www.dezeen.com/2011/07/01/agbaria-house-by-ron-fleisher-architects/>, (03/2015).*

Technological data of the perforated envelope

Construction & perforation parameters

Question		Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	NA	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope

Passive design parameters

Question		Answer options				
Q.19	What is the designer’s intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others
Q.21	What is the facades’ daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios

Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: Liwan	No				
Active design parameters							
Question		**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate	Low	NA		
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		

Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 54: 4 Houses - KSA

Structured information

Building location:	Jeddah-KSA	Architect/s:	Dom Arquitectura	Site topography:	Flat Land
Construction date/s:	2014	Site context:	Suburban	Climatic zone:	Dry arid
Building use:	Residential	Users group:	All genders-All ages	Floors number:	3 Floors

Visual information

Ref: <http://www.greenprophet.com/2014/01/4-houses-islamic-shutters-saud-arabia/>, (06/2015).

Textual information

The architect used Islamic and passive designs to keep the homes cool while temperatures in the Gulf countries maybe steadily rising as climate change escalates, it's always been hot on the peninsula. Lacking modern conveniences such as air-conditioning, pre-industrial builders devised several ingenious methods to keep building interiors comfortable, many of which were lost to contemporary designers. While using earth construction is still uncommon, studios such as Dom "Arquitectura" are beginning to incorporate ancient Islamic techniques such as "Mashrabiya" screens, courtyards and plants into modern constructions for non-mechanical climate control. The 4 Houses in Jeddah are arranged around a central courtyard in a fairly uniform pattern mandated by the site's layout. The ground floor was built with concrete and wood, the floors rise from foundation in a fairly standard open box style. Like traditional Islamic buildings, the central courtyard filled with natural light and plants provides natural cooling by cross ventilation; sliding shutters act like a second skin that create a transition zone between the main interior and outside. The "Mashrabiya-like" wall screens not only provide ventilation, but also views and a sense of privacy. The homes' lower level walls are particularly well-screened from the outside, while the upper levels are more open.

Ref: <http://www.greenprophet.com/2014/01/4-houses-islamic-shutters-saud-arabia/>, (06/2015).

Technological data of the perforated envelope

Construction & perforation parameters

	Question	Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						

Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant	
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant	
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA	
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces		
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA	
Environmental indicators of the perforated envelope							
Passive design parameters							
Question		**Answer options**					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	5:1
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: courtyards & planting	No				
Active design parameters							
Question		**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		

Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		Answer options					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 55: Concrete House

Structured information					
Building location:	Tal Arabee'-Palestine	Architect/s:	Pitsou Kedem	Site topography:	Flat Land
Construction date/s:	2014	Site context:	Suburban	Climatic zone:	Moderate climate
Building use:	Residential	Users group:	All genders-All ages	Floors number:	2 Floors

Visual information	Textual information
 	The main volume of the building is a concrete shell that extends around a courtyard, and also frames the large glazed surfaces or openings containing the gridded metal screens. Weathered steel screens cast checker board patterns of sunlight and shadow across the internal surfaces of this house, these see-through surfaces perform several purposes -controlling the amount of daylight that enters the building, limiting views from outside and helping to demarcate boundaries between various internal and external spaces. A courtyard marks the entrance to the house and is sheltered on two sides by tall concrete walls. At first floor level, the concrete frames the metal screen, which extends along the front of the building and wraps around the corner to shield a bedroom. Another courtyard at the other end of the house creates a transitional area between the living area and the pool. This also becomes carpeted in a pattern of dappled sunlight as it filters through the screens that flank it on two sides. The sun's orientation helped to determine several key factors, including the position of walls and the internal program. The choice of simple raw materials, including exposed concrete, was intended to enhance the "inanimate" and "monastic" properties of these surfaces. The shade and shadows moving across the building's surfaces create a dynamic drama that makes the entire mass seem to be alive and full of movement," the studio added. Glass walls enhance the open-air feel of the ground floor, where residents can look out onto the pool from the living room and kitchen. Glazing also surrounds small courtyard gardens. One is positioned next to the main stairwell, containing a tree that reaches up from the basement level. In first floor spaces such as the master bedroom, the pattern of light and shadow cast by the perforated metal screen outside the glass wall evokes the effect of dappled light filtering through the nearby trees.
Ref: <http://www.dezeen.com/2015/02/21/pitsou-kedem-israel-in-praise-of-shadows-house-perforated-screens/>, (04/2015).	*Ref: <http://www.dezeen.com/2015/02/21/pitsou-kedem-israel-in-praise-of-shadows-house-perforated-screens/>, (04/2015).*

Technological data of the perforated envelope									
Construction & perforation parameters									
Question		**Answer options**							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope							
Passive design parameters							
Question		**Answer options**					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: cavity	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	20:1
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: planting	No				

Active design parameters						
Question		**Answer options**				
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA		
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA	
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others		
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA		

Q.36	Are there other used active design techniques/elements?	Yes: specify		No	NA		
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials		NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades		NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades		No	NA
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades		No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades		No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades		No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades		No	
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades		No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades		No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades		No	
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 56: Ngamwongwan House

Structured information

Building location:	Bang Khen-Thailand	Architect/s:	Junsekino	Site topography:	Flat Land
Construction date/s:	2014	Site context:	Suburban	Climatic zone:	Tropical
Building use:	Residential	Users group:	All genders-All ages	Floors number:	2 Floors

Visual information

Ref: <http://www.archdaily.com/615040/ngamwongwan-house-junsekino-architect-and-design>, (05/2015).

Textual information

The initiation of the project with the primary concept that focuses on the curiosity of the most common inexpensive material, the brick. Due to the increasing cost of the land in the urban area like Bangkok, the demand to own a house needs some prudent deliberation. The architect wanted thus building to be antique as it is completed. In addition, this building needs to give the humble feeling and exposes itself directly without any adornment. The house owner claims that he spends most of his time with his parents in this house; therefore, the design of this house needs to meet his demand which can respond to his lifestyle during both daytime and nighttimes, also this building was built to reflect the tropical living lifestyle. Consequently, the construction of two-layer brick walls in which each wall is 30-centimeter thick with the space in between can be functioned as the heat insulator, since the heat can only pass through the outer wall but not the inner wall. Moreover, the soil also possesses special quality which is easier to be heated up yet easier to be cooled down. The opening of the court at the house’s centre in which the main building acts as the sunshade since 10 o’clock together with the inner glass wall allow the air to flow comfortably. The utilization of the natural light in every part of the house convinces the tenants not to feel like living alone since there are the visual connection points.

Ref: <http://www.archdaily.com/615040/ngamwongwan-house-junsekino-architect-and-design>, (05/2015).

Technological data of the perforated envelope

Construction & perforation parameters

	Question	Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Brick	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	NA	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope

Passive design parameters							
Question		**Answer options**					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: courtyard	No				

Active design parameters						
Question		**Answer options**				
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA		
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA	
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others		
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA		
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA		

Socio-cultural indicators of the perforated envelope

Usability, adaptability, and connectivity						
Question		**Answer options**				
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA		
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA	
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA	
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No	
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No	

Economic indicators of the perforated envelope

Initial costs, running costs, and maintainability					
Question		**Answer options**			
Q.48	What is the perforated material's relative initial costs?	High	Moderate	Low	NA
Q.49	Does the perforation technique have independent costs?	Yes	No	NA	
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA	

Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 57: Casa PetriniVillani

Structured information

Building location:	Polignano a Mare-IT	Architect/s:	Antonella mari	Site topography:	Flat Land
Construction date/s:	2008-2011	Site context:	Suburban	Climatic zone:	Moderate climate
Building use:	Residential	Users group:	All genders-All ages	Floors number:	2 Floors

Visual information

Ref: <http://www.archello.com/en/project/casa-petrini-villani#>, (05/2015).

Textual information

The house for a psychologist, a nurse and their young daughter is designed as the extension of an existing one-floor building in the historic centre of Polignano a Mare. While the old facade remains almost unmodified, the new volume above is clearly defined through the use of lighter materials: a double skin system - made of glass/aluminium large windows screened by steel and wood retractable panels - allows natural light in while preventing heating. About 4.000 movable wooden tiles create a pixilated reconfigurable front, and generate always changing shadows effects inside. The project aims to open a dialogue between old context and contemporary language, natural material and digital realm, while focusing on the importance of perception and phenomenological aspects in built space. The opposite ideas of the ruin and of the unfinished are expressed in the design as a link between past and future.

Ref: <http://www.archello.com/en/project/casa-petrini-villani#>, (05/2015).

Technological data of the perforated envelope

Construction & perforation parameters

	Question	Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						

Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant	
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant	
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA	
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces		
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA	
Environmental indicators of the perforated envelope							
Passive design parameters							
	Question	**Answer options**					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	20:1
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: 4000 movable tiles	No				
Active design parameters							
	Question	**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
	Question	**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		

Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		Answer options					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 58: Daily Dream Home-Harold Street

Structured information					
Building location:	Melbourne-Australia	Architect/s:	Jackson Clements Burrows	Site topography:	Flat Land
Construction date/s:	2012	Site context:	Suburban	Climatic zone:	Moderate climate
Building use:	Residential	Users group:	All genders-All ages	Floors number:	2 Floors

Visual information

Ref:<http://www.homedsgn.com/2012/12/04/harold-street-residence-by-jackson-clements-burrows/>, (06/2015).

Textual information

The Harold Street Residence was designed to become the perfect home for a couple with university age children. Set in a neighbourhood landscape dominated by single story Victorian terraces, this contemporary residence explores a detailed engagement with the street, as well as a seamless connection between the garden and interiors. The architectural studio addressed the corner lot placement by creating a translucent cut into the architecture, exploring the private-public connections. The more private northern half of the site was adorned with a garden, creating continuous indoor-outdoor interactions. Pressed red brickwork defining a dynamic contemporary architecture are showcased as playful punctured detailing across the corner property (www.pursuitist.com). The pressed red brickwork and sweeping roof form seek to reconcile the house within its surrounding context. The brickwork is further articulated by 'hit and miss' detailing and web forge screening, providing a perforated layer between street and the internal spaces.

Ref:<http://www.homedsgn.com/2012/12/04/harold-street-residence-by-jackson-clements-burrows/>, (06/2015).

Technological data of the perforated envelope									
Construction & perforation parameters									
Question		Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added		Previously built					
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					

Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated		
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Brick
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels					
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	NA
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others		
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant			
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays					
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant		
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant		
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA		
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces			
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA		
Environmental indicators of the perforated envelope								
Passive design parameters								
Question		**Answer options**						
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others		
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others		
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios		
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No				
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant		
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA			
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA			
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA			
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others	
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA			
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA			
Q.30	Are there other used passive design techniques/elements?	Yes: specify	No					
Active design parameters								
Question		**Answer options**						
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA		
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA				
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA			
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others				
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA				
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA				
Socio-cultural indicators of the perforated envelope								
Usability, adaptability, and connectivity								
Question		**Answer options**						
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA				
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA			
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA			
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA		

Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades		No	NA
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades		No	
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades		No	
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades		No	
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades		No	NA
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades		No	
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades		No	
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 59: Local House

Structured information					
Building location:	Saint Kilda-Australia	Architect/s:	MAKE architecture	Site topography:	Flat Land
Construction date/s:	2014	Site context:	Urban	Climatic zone:	Moderate climate
Building use:	Residential	Users group:	All genders-All ages	Floors number:	2 Floors

Visual information

Ref:<http://www.archdaily.com/620039/local-house-make-architecture/>, (06/2015).

Textual information

The existing Californian Bungalow has been kept intact with the addition of a new contemporary ‘gable like’ 2 storey element to the rear. The new volume is shifted off the side boundary to open up the living spaces to the sun and to connect the kitchen/dining space to the rear garden. Off-form concrete has been used to form a heavy base with large expressed vertical elements connecting the base to the site. Concrete has also been used internally to create integrated seats, benches and durable surfaces for family life. Floating over the base, a decorative timber screen fills the end of the upper extruded gable roof form, giving warm contrast to the concrete and containing the main bedroom within. The angled panels of the screen mediate the sun and control overlooking to the neighbours, while still providing distant views over the rooftops beyond. Social sustainability has also been an important consideration in the design.

Ref:<http://www.archdaily.com/620039/local-house-make-architecture/>, (06/2015).

Technological data of the perforated envelope

Construction & perforation parameters

	Question	Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	Others	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			
Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant			
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA			
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces				
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA			

Environmental indicators of the perforated envelope

Passive design parameters

	Question	Answer options				
Q.19	What is the designer’s intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others
Q.21	What is the facades’ daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios

Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: variant perforation angles	No				
Active design parameters							
Question		**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		
Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		**Answer options**					
Q.48	What is the perforated material's relative initial costs?	High	Moderate	Low	NA		
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		

Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

Case 60: Kahrizak Residential Project

Structured information

Building location:	Tehran- Iran	Architect/s:	CAAT Studio	Site topography:	Flat Land
Construction date/s:	2015	Site context:	Suburban	Climatic zone:	Dry semiarid
Building use:	Residential	Users group:	All genders-All ages	Floors number:	6 Floors

Visual information

Ref: <http://www.archdaily.com/633253/kahrizak-residential-project-caat-studio/>, (05/2015).

Textual information

The main goal of this project was designing a construction enjoying quality and providing affordability. The choice of material was a significant parameter in this project to be affordable and easy to freight to the site. As a result, clay blocks were considered and were produced locally. The least expensive material that gave the ability to create the desired sense of space was concrete. The units were sold-out during the construction phase with the same price of a finished building in the neighbourhood while there was so many completed buildings left unsold. As it may be seen in the project images, the designer used clay blocks in the façade in a way that cover some parts of the terraces. Brick modules' designs are based on Iranian geometrical patterns; each module was designed in relation with the function of the space behind it. Having variety in brick modules they are coherent and homophonic. That's how it resulted in a smooth facade to represent both Iranian brick architecture and the essence of residential. In addition, this geometry is concrete for local workmen and thus it facilitates the construction process. The geometry is also present in traditional residential architecture of desert areas of Iran.

Ref: <http://www.archdaily.com/633253/kahrizak-residential-project-caat-studio/>, (05/2015).

Technological data of the perforated envelope

Construction & perforation parameters

	Question	Answer options							
Q.1	What is the type of intervention of the perforated envelope?	Newly added	Previously built						
Q.2	What is the number of the perforated facades/faces?	1 face	2 faces	3 faces	4 faces	More			
Q.3	How many façades/faces are fully-perforated?	1 face	2 faces	3 faces	4 faces	More	None		
Q.4	What is the orientation of the perforated faces?	S	N	E	W	SE	SW	NE	NW
Q.5	What is the shape of the perforated faces of the envelope?	Flat	Folded	Curved	Inclined	Irregular	Variant	Others	
Q.6	What is the number of perforated layers in the envelope?	1	2	More					
Q.7	What is the type of roof perforation?	Perforated dome	Flat	Inclined	Others	Not perforated			
Q.8	What is the type of perforated material?	Wood	Concrete	Metal	Stone	Earth	Glass	Brick	
Q.9	How was the perforation created?	By interlocking of blocks	By drilling the panels						
Q.10	What is the type of material behind the perforated layer?	Wood	Concrete	Metal	Stone	Earth	Glass	NA	
Q.11	What is the perforation pattern shape?	Primitive geometries	Floral	Symbolic	Irregular	Others			
Q.12	What is the perforation approximate sizing?	Very tiny-sized	Small-sized	Large-sized	Variant				
Q.13	What is the configuration type of perforation	Regular arrays	Irregular arrays						
Q.14	What is the approximate perforation ratio in each face?	1-10%	11-35%	36-50%	Over 51%	Variant			

Q.15	What is the approximate thickness of the perforated layer?	1- 9 mm	1-5 cm	5-30 cm	Over 30 cm	Variant	
Q.16	What is the approximate depth of air cavity?	<0.59m	0.6- 1m	Over 1m	Variant	NA	
Q.17	Does the perforated layer have open-able elements?	Yes	No	Few	Not in all faces		
Q.18	For partial perforations, are there windows beside perforation?	Yes	No	Few	Not in all faces	NA	
Environmental indicators of the perforated envelope							
Passive design parameters							
Question		**Answer options**					
Q.19	What is the designer's intention of creating the perforation?	Environmental	Socio-Economic	Aesthetic	Conceptual	Others	
Q.20	What is the purpose of orientating the perforated facades?	Environmental	Not considered	Inevitable	Conceptual	Others	
Q.21	What is the facades' daylight transmittance ration (openness)?	1-10%	11-35%	36-50%	Over 51%	Variant ratios	
Q.22	Does the envelope's design consider the passive cooling and natural ventilation?	Yes	Slightly	No			
Q.23	What is the perforated material's source category?	Conventional	Modified conventional	Man-made common	Man-made modified	Variant	
Q.24	What is the level of perforated material's thermal capacity?	High	Moderate	Low	NA		
Q.25	Does the perforated layer have insulations?	Yes: specify	No	Not in all facades	NA		
Q.26	Does the layer behind/front the perforation have insulations?	Yes: specify	No	Not in all facades	NA		
Q.27	What is the proportion of hole's size to the layer thickness?	1:1	1.5:1	1:1.5	2:1	1:2	Others
Q.28	What is the level of material's resistance to moisture and rain?	High	Moderate	Low	NA		
Q.29	Does the perforated layer help in decreasing the heat transfer?	Yes: specify	No	Slightly	NA		
Q.30	Are there other used passive design techniques/elements?	Yes: sunshades	No				
Active design parameters							
Question		**Answer options**					
Q.31	What is the way of opening/moving the envelope's elements?	Manual	Electro-mechanical	Smart	Others	NA	
Q.32	What norm of energy is used for electro-mechanical controls of dynamic envelopes/panels?	Renewable energy	Non-renewable energy	NA			
Q.33	Does the envelope's design enhance the energy-saving?	Yes	Slightly	No	NA		
Q.34	Does the perforation need technology for manufacturing?	Yes: prefabricated panels	No: manually created	Others			
Q.35	Does the building have some awards/certificates?	Yes: specify	No	NA			
Q.36	Are there other used active design techniques/elements?	Yes: specify	No	NA			
Socio-cultural indicators of the perforated envelope							
Usability, adaptability, and connectivity							
Question		**Answer options**					
Q.37	Does the perforation pattern indicate a cultural symbolism?	Yes	No	NA			
Q.38	Is the perforated material commonly used by the community?	Yes	No	Not all used materials	NA		
Q.39	Is the air cavity accessible for building's occupants?	Yes	No	Not in all facades	NA		
Q.40	Does the perforation sizing impede or obscure occupants' view-ability to outside, if there is no open-able elements?	Yes	Slightly	Not in all facades	No	NA	
Q.41	In case of double-skin, does the air cavity impede or obscure occupants' view-ability to outside?	Yes	Slightly	Not in all facades	No	NA	
Q.42	Does the perforation's configuration impede or obscure view-ability from some internal spaces of the same facade?	Yes	Slightly	Not in all facades	No		
Q.43	Does the perforation's configuration increase visual privacy?	Yes	Slightly	Not in all facades	No		
Q.44	Do the perforation ratios and proportions enhance the acoustical insulation performance of the envelope?	Yes	Slightly	Not in all facades	No		
Q.45	In case of double skin, does the air cavity impede or obscure the occupants' verbal contact with outside persons?	Yes	Slightly	Not in all facades	No	NA	
Q.46	Does the perforation increase the physical security?	Yes	Slightly	Not in all facades	No		
Q.47	Does the perforation increase the occupants' visual privacy?	Yes	Slightly	Not in all facades	No		

Economic indicators of the perforated envelope							
Initial costs, running costs, and maintainability							
Question		Answer options					
Q.48	What is the perforated material's relative initial costs?	High	Moderate		Low	NA	
Q.49	Does the perforation technique have independent costs?	Yes	No	NA			
Q.50	Does the dynamism of the perforated layer have running cost?	Yes	No	NA			
Q.51	Do the perforations decrease the building's running costs?	Yes	Slightly	No	NA		
Q.52	Is the perforated material considered as durable?	Yes	Slightly	No	NA		
Q.53	Is the perforated material locally available?	Yes	Slightly	No	NA		
Q.54	Is the rain penetration considered in the envelope's design?	Yes	Slightly	No	NA		
Q.55	Is the dust accumulation considered in the perforation design?	Yes	Slightly	No	NA		
Q.56	Is the birds nesting considered in the perforation design?	Yes	Slightly	No	NA		
Q.57	Is the perforated material recyclable?	Yes	Slightly	No	NA		
Q.58	Is the perforated layer easily cleanable?	Yes	No				
Q.59	Is the layer behind/in front of perforation easily cleanable?	Yes	No	NA			
Q.60	Are the perforated panels easily maintainable/changeable?	Yes	No				

The Perforated Building's Envelope: Guiding The Early Design Phases