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The journal aims to be a platform for the studies of design, education and application and has a goal to be a bridge in between traditional/modern, east/west, local/global in the disciplines of Architecture / Planning.

Architecture and Planning, as two interconnected fields, are strongly affected by other disciplines such as fine art, urban design, philosophy, engineering, geography, economics, politics, sociology, history, psychology, geology, information technology, ecology, law, security and management. However, there are no academic journals which specifically focus on the connections of architecture and planning with other social fields. **ICONARP** aims to fill that gap. Our scope is to provide a suitable space for theoretical, methodological and empirical papers, which use global and local perspectives together, in architectural and urban studies.

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EDITORIAL

ICONARP began its broadcast life as peer-reviewed faculty journal in the field of international architecture and planning and now it is the sixth issue.

ICONARP is continuing its growing process with this new issue.

The seventh issue will be published in June and we wait for your contributions with your scientific studies until April 15th 2016

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A Critical Review on The Current Thought and Practice of Urban Design: New Roles in the Future

Derya Oktay

Abstract

Though urban design is historically rooted in development of cities, urban design, as a contemporary discipline, is relatively new compared to associated disciplines of architecture, urban planning, and landscape architecture. Urban design's close connection with these allied disciplines has also been the reason for its ambiguous nature, and its muddled definition. Accordingly, it is claimed here that a reexamination of the definition, status, and role of urban design is essential for the future directions of urban design as a discipline and cities as sustainable environments. In line with this, this article provides a critical framework regarding the current understanding of the discipline of urban design which is based on form, policy and

Keywords:
Urban Design, current status, problems, future role, urban designer.

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efficiency, and highlights the need for place oriented approaches performed in an interdisciplinary working framework. The paper first focuses on the meaning and significance of urban design, and discusses the problems with the manner in which urban design is conceived, practiced and researched. Second, it interrogates the contemporary framework of urban design where the notions of 'urban' and 'design' are being disconnected. Third, it examines the changing role of urban design from the traditional to the contemporary mainstream approaches. The conclusion suggests lessons in terms of understanding and framing its scale, content, professional formation, interdisciplinary nature and role in sustainable urban environments.

INTRODUCTION

Over the past three decades, the advent of a post-industrial economy, the rise of the environmental movement, and the critique of top-down government decision-making have called for new approaches, both conceptually and methodologically, to the design and construction of urban environments. In this context, there appears a need for a critical urban design framing the increasingly contested terrain of urban resources and environments that addresses the emerging global trends, complex urban patterns, and evolving challenges of urbanization (UN Habitat, 2009).

Though urban design is historically rooted in development of cities, urban design, as a contemporary discipline, is relatively new compared to associated disciplines of architecture, urban planning, and landscape architecture. Urban design's close connection with these allied disciplines has also been the reason for its ambiguous nature, and its muddled definition. Accordingly, it is claimed here that a reexamination of the definition, status, and role of urban design is essential for the future directions of urban design as a discipline and cities as sustainable environments.

This article, following this introduction, first provides an understanding of the meaning and paradox of urban design, and discusses the problems with the manner in which urban design is conceived, practiced and researched. Second, it presents a critical framework where the notions of urban and design are being disconnected. Third, the changing role of urban design from the traditional to the contemporary mainstream approaches, and towards sustainable urbanism is explored. The conclusion highlights the dimensions of responsive urban design in order for urban design practices to have impact on ill-planned development in many world cities in a fast changing context.

THE CURRENT UNDERSTANDING AND POSITION OF URBAN DESIGN

As defined in *By Design,* a guidance manual commissioned by the UK Government for local authority planners incorporating the conventional approach to good urban design (ODPM - UK, 2003), "urban design is the art of making places for people… it concerns the connections between people and places, movement and urban form, nature and the built fabric, and the processes for ensuring successful villages, towns and cities".

On the contrary to its position in the 1980s, the value of urban design has been widely acknowledged over the last three decades. In the West, it is now well integrated in the planning system. Urban designers increasingly occupy a central role in the development and redevelopment of cities. Design professionals with good urban design knowledge and skills are much sought after by private consulting firms, development organizations and local and state governments – where they are required to prepare and evaluate urban design policies, strategies, frameworks, guidelines, concepts, master plans and programs, as well as be involved in the more detailed design and management of urban spaces. Urban design knowledge and skills also assist in designing for specific sites by providing a better appreciation of urban structure and context.

However, only fairly recently has urban design been identified as a specific discipline. It encompasses practices which have always had a central place in urban planning and urban development, though with new techniques and different points of emphasis related to contemporary issues. The need for such a discipline has arisen as a result of the fundamental cultural, political, social and economic changes. These have focused attention on environmental issues and the quality of life, on the nature of the city and on how urban form can best be adapted to our current and future needs (Lloyd-Jones 1998).

PROBLEMS WITH CURRENT THOUGHT AND PRACTICE OF URBAN DESIGN

At present, there are problems with the manner in which urban design is conceived, practiced and researched. Owing to the emphasis on morphological aspects (physical aspects of the urban environment), that is the result of the stress on the problematic effect of negative space, urban design is often regarded as an ambiguous combination of architecture, urban planning, and landscape architecture. In this context, the qualities of the physical environment are perceived as being detached from urban use and appropriation as they would be discussed, for example, by Jacobs (1961) and Alexander (1976), who regards the city primarily as a place of human habitation. Concentrating on the abstract concept of the spatial experience rather than on actual day-to-day life has ignored the users and their functional, social and emotional needs. Thus, although the city is examined and designed on the implicit basis of human experience, this experience is never discussed or considered specifically enough to make a difference (Kallus 2001).

Is urban design‘ architecture at a larger scale'?: Another problem with current urban design thought and practice is the sense that it has become almost synonymous with 'architecture at a larger scale' made up of building facades or building complexes, or designing 'objects' rather than creating 'places'. In line with this approach, there is too much emphasis on the visual and contextual dimensions of the townscape, an over-emphasis on the architect as urban designer and an obsession with design of individual buildings, and not enough consideration of 'urban context' (e.g. how cities work) (Lloyd-Jones 1998, Inam 2002) and building and urban space relationship. Accordingly, the profession has become very 'product' oriented, and the resulted urban environment has failed in terms of livability and sense of place.

Even when architects want to take the city into consideration, what precisely they take into account are mainly the visual aspects; however, it is just as important for the design to fulfill the physical, social, emotional and spiritual needs of the people who use the environment. In this context, there are some architects like Ralph Erskine, Lucien Kroll, and Herman Hetzberger who are worth mentioning as they have contributed through their architecture and writing to designing with people in mind, through their idiosyncratic approaches to making healthier and happier places for people to live in.

Another useful distinction of urban design lies in the relationship between the designer and the designed object. All designers (architect, interior designer, industrial designer, etc.), except contemporary urban designers, have a direct relationship with the object that they design, as schematically depicted in Figure 1. These designers make the decisions that dictate and directly shape the object. However, as depicted in Figure 2, contemporary urban designers have only an indirect relationship with the designed object. They shape the designed object by influencing decisions made by other designers who then directly shape the object; they design the decision environment within which other designers (both professional designers and non-designers whose decisions shape the built environment) create the designed object. In this context, there arises a problem of lack of control on the designed product, an issue highlighted by

George (1997, 150) by using the term ‘second-order activity’ when describing urban design.

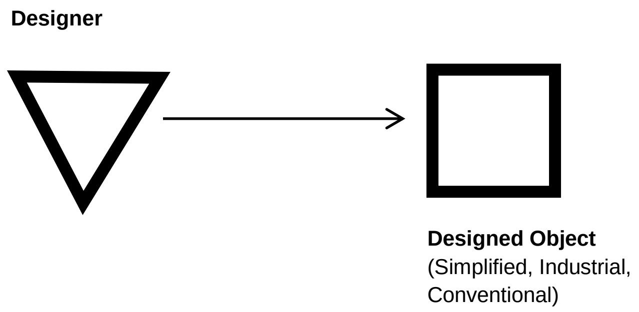

Figure 1. The relationship between the typical designer and the designed object.

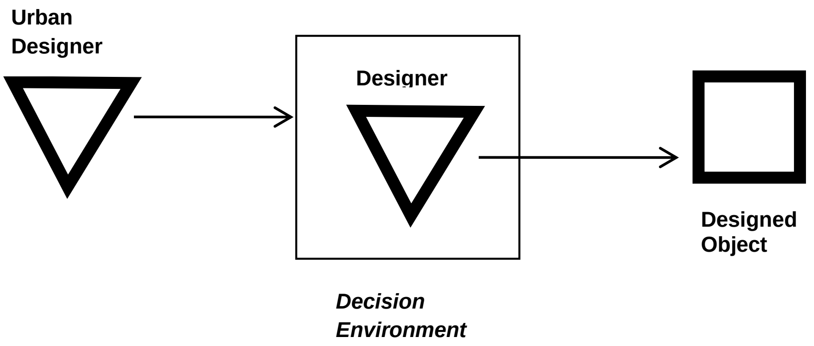

Figure 2. The indirect relationship between the urban designer and the designed object in contemporary cases (George, 1997).

Expectations from urban designers: In terms of the knowledge-base, like architects, urban designers must be knowledgeable about forming and manipulating spaces, and must be sensitive to the quality of spaces. This is the only area of knowledge where the two fields completely overlap. The second area of the architect’s knowledge-base, knowledge of user characteristics or the relationships between people and the built environment, is also shared by the two fields. However, urban designers need additional skills and knowledge of the urban context; they must know about urban systems and processes of change in urban areas. Further, there is a need for urban design to be informed by concepts, methods, and lessons from sociology, anthropology, cultural landscape studies, environmental psychology, geography, climatology, the management studies, and even art, in addition to obvious disciplines such as architecture, urban planning, and landscape architecture. As no single person can encompass all this knowledge and bring it to reflect on decision making and design, urban design will and should remain a collaborative task.

The question of professional formation: One question that has often been a point of discussion is "who are urban designers?" In the prevalent paradigm of urban design pedagogy, urban designers are primarily trained as architects, planners or engineers, each having one's own design bias. Architects see design as formal orientation in space. Planners conceive design as regulatory framework and implementation of policies reflecting social and economic value. Engineers understand design as efficiency in production. These divergences imply a problem of communication and the necessity of language of urban design to have a role of bridging.

On that front, a higher level qualification in urban design following an undergraduate degree in architecture is crucial. In this way, as depicted in Figure3, the architect - urban designer can take the lead in a multi-disciplinary team and direct the urban design process in a decision environment informed by a variety of disciplines, such as politics, sociology, anthropology, cultural landscape studies, environmental psychology, geography, climatology, management studies, public art, and so forth.

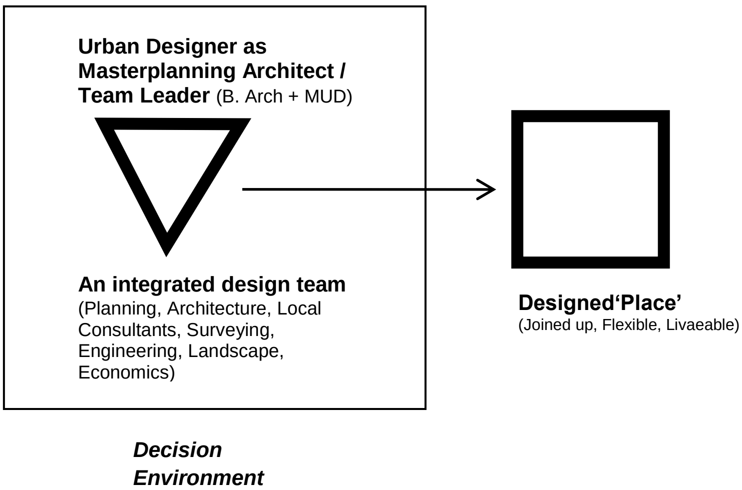

Figure 3. The proposed formation for the urban designer and his/her relationship with the designed object.

The institutional framework: As for the institutional framework, how urban design best fits into the professional world is an area of continuing debate. There are (as yet) no professional bodies to dictate what should be on the curriculum of an urban design degree program, nor what sorts of specific expertise and knowledge are needed to practice as an urban designer. This is not a coincidence; it is generally agreed that urban design is not a distinct profession in itself so much as a way of thinking, or, to paraphrase Britain's Urban Design Group, as common ground among a number of professions and/or the wide range of people involved in urban change. To practice urban design, however, an individual should be a registered member of professional regulating bodies in architecture, landscape architecture, and/or urban planning.

THE NEW ROLES FOR URBAN DESIGN

Understanding the role of urban design is essential for providing positive orientations in its future directions. Traditionally, based on the most common understanding that urban design is the interface between urban planning and architecture, it plays a mediator role between two major disciplines involved in the urban realm, but at different levels and scales.

Objectives of the contemporary mainstream approach to urban design: The following objectives of the contemporary mainstream approach to urban design based on the contributions of a number of European and American academics, theorists and practitioners from the 1950s onwards make it clear what roles a responsive urban design activity may play: (Lloyd-Jones 2006)

- *Character and identity*: to promote character in townscape and landscape by responding to and reinforcing locally distinctive patterns of development, landscape and culture.
- *Continuity and enclosure*: to promote the continuity of street frontages and the enclosure of space by development that clearly defines private and public areas.
- *Quality of the public realm*: to promote public spaces and routes that are public spaces and routes that are attractive, safe, uncluttered and work effectively for all in society, including disabled and elderly people.
- *Ease of movement*: to promote accessibility and local permeability by making places that connect with each other and are easy to move through, putting people before motor car and integrating land uses and transport.
- *Legibility*: to promote legibility through development that provides recognizable routes, intersections and landmarks to help people find their way around.
- *Adaptability*: to promote adaptability through development that can respond to changing social, technological and economic conditions.
- *Diversity*: to promote diversity and choice through a mix of compatible developments and uses that work together to create viable places that respond to local needs.

New roles in the context of sustainable urbanism: In a widening context, urban designers are now being given new roles being called upon to address development issues in all types of context, green field, suburban and inner-city and brown field regeneration, as well as the city centers. Ecologically sustainable, higher-density, mixed-use, permeable neighborhoods and centers with well-structured, pedestrian and public-transport orientated features have been developed. Conventional urban design contributes greatly to the policies required to achieve the sustainable development of rich world cities, most of which are not growing very much in population but continue to eat up land and natural resources, and to damage social life.

CONCLUSIONS

Urban design lies at the intersection of the interests of the three main professions concerned with the layout of the environment – architecture, landscape architecture and urban planning. However, urban design while overlapping these fields has developed its own area of expertise.

Since current urban design thought and practice have recently been dominated by the visual and contextual understanding of the townscape, and in many cases has become almost synonymous with 'architecture at a larger scale', there is a need for a paradigmatic shift in the focus of urban design from the current model of urban design framework, where the social control, economic efficiency, and spatial order are compartmentalized. The focus on understanding urban, on the contrary, requires an adaptive inclusive model that addresses relational issues among multiple dimensions of urban design and the urban environment. In brief, a dynamic multi-dimensional viewpoint is required which combines political, environmental, economic and cultural aspects of urban design and development in the changing of the city.

As these deliberations suggest, we should be aware of the fact that urban design is different from architecture! It requires additional skills and knowledge of the urban context. Further, there is a need for urban design to be informed by concepts, methods, and lessons from sociology, anthropology, cultural landscape studies, environmental psychology, geography, climatology, the management studies, and even art, in addition to obvious disciplines such as architecture, urban planning, and landscape architecture. As no single person can encompass all this knowledge and bring it to reflect on decision making and design, urban design will and should remain a collaborative task.

The problem of communication between architects, who see design as formal orientation in space, and planners, who have problems with the language of design, compels the necessity of language of urban design to have a role of bridging. On that front, a higher level qualification in urban design following an undergraduate degree in architecture is crucial. Such a formation would also enable the architect to develop interdisciplinary critical skills to build better places, and acquire the role of the 'master planning architect' within an integrated design team.

If urban design is to have any impact at all on ill-planned sprawling development in many world cities in a fast changing context, it needs to look to a wider landscape understanding of character and identity, to relationships between built form that are not exclusively focused on continuity and enclosure; to consider more accessible and communicative city and legibility beyond the street environment, roads and public transport interchanges; to give much greater concern to the legibility of the urban and suburban landscape; and to focus on the requirements of sustainable urbanism for safeguarding the natural, built and cultural values in our cities.

REFERENCES

Barnett, J. (1974), *Urban Design as Public Policy*. NewYork: McGraw Hill.

Batchelor, P. & Lewis, D. (Eds.) (1986), Urban Design in Action. Raleigh: North Carolina State University.

Bentley, I. et al. (1985), *Responsive Environments: A Manual for Designers*. London: Architectural Press, London.

Cullen, G. (1971), *The Concise Townscape*, London: Butterworth Architecture.

ODPM– UK (2003), *By Design: Urban Design in the Planning System - Towards Better Practice*. London: Commission for Architecture & the Built Environment.

Girardet, H. (2004), *Cities, People, Planet*. Chichester: John Wiley and Sons.

Greed, C. (1998), "Definitions and Perceptions of Urban Design", *Introducing Urban Design: Interventions and Responses* (Eds: C. Greed & M. Roberts). Essex: Pearson Education, pp. 3-14.

George, R. V. (1997), "A Procedural Explanation for Contemporary Urban Design", *Journal of Urban Design,*2 (2), pp. 143-162.

Inam, A. (2002), "Meaningful Urban Design: Teleological/Catalytic/Relevant", *Journal of Urban Design*, 7 (1), pp. 35-58.

Jacobs, J. (1961), *The Death and Life of Great American Cities*, New York: Random House.

Kallus, R. (2001), "From Abstract to Concrete: Subjective Reading of Urban Space", *Journal of Urban Design*, 6 (2), pp. 129-150.

Karaman, A. (2008), Kentsel Tasarım: Kuramlar, İlkeler, Roller, *Mimar.Ist*, 8 (3), pp. 34-42.

Kelbaugh, D. S., (2002), *Common Place Revisited*. Seattle: Washington University Press.

Krieger, A. (2006), *The Territories of Urban Design*. London: Routledge.

Lang, J. (2005), *Urban Design: A Typology of Procedures and Products.* Oxford: Architectural Press.

Lifchez, R. (1981), "Designing with People in Mind", *Journal of Architecture and Planning Research*, Special Issue, XXXV (1), 36-40.

Lloyd-Jones, T. (1998), "The Scope of Urban Design", *Introducing Urban Design,* pp. 15-35.

Lynch, K. (1971), *A Theory of Good City Form*, Cambridge, Mass: The MIT Press.

Madanipour, A. (1997), "Ambiguities of Urban Design", *Town Planning Review,* Vol. 68, No.3, pp. 363-383.

Moughtin, C. et al (2003), *Urban Design: Method and Techniques*. Oxford: Architectural Press.

Oktay, D. (2008), "Kentsel Tasarım ve Kamusal Alan: Kavram, Uygulama ve Eğitim Bağlamında Değerlendirmeler", *Mimar.Ist*, 8 (3 - 28), pp. 50-57.

Oktay, D. (2008), "Architectural Education and Social Perspectives: Establishing The Human Context of Everyday Urban Life through Design Studios", *The Oxford Conference: 50 years on: Re-setting the Agenda for Architectural Education,* Oxford, July 2008.

Oktay, D. (2004), "Urban Design for Sustainability: A Study on the Turkish City", *International Journal of Sustainable Development and World Ecology.* Vol. 11, March 2004, pp. 24-35.

Rogers, R. (1999), *Towards Urban Renaissance*. London: E & FN Spon.

Rossi, A. (1982),*The Architecture of the City*. Cambridge, Mass.: MIT Press.

Schurch, T. W. (1999), "Reconsidering Urban Design: Thoughts about its Definition and Status as a Field or Profession", *Journal of Urban Design*, 4 (1),pp. 5-28.

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Innovative Technologies for the Protection of Historical Structures against Earthquakes

Fuat ARAS

Abstract

Cultural heritage buildings are special structures and must be protected from natural disasters preserving at the same time their authenticity. In the seismic areas, one of the building classes that is consistently exposed to seismic risk is the one constituting the architectural heritage of the region. To minimize further destruction under future seismic activity it is necessary to reinforce the existing structures that are more vulnerable. As a consequence, new technological systems are needed, able to provide solution not only to specific structural or architectural problems, but also aiming at improving the global performance of the construction. Similarly, great attention is paid not only to reliability and durability of intervention methods, but also to the possibility to be easily monitored and removed if required, according to the widely shared policy, aiming at the safeguard of existing buildings, in particular in case of historical and monumental works, from inappropriate restoration operations.

Keywords: *historical structures, preservation, innovative method*, *reversibility*

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This study aims to represent innovative technologies and strategies to preserve the cultural heritage structures against earthquake effect. In particular, the application of fibre reinforced polymers and structural control systems are explained. Suitability of the strategies to architectural, historical and structural features and reversibility aspects are evaluated. As a case study the application of these strategies to a historical building in Istanbul is discussed.

INTRODUCTION

With its permanent occupancy over 8000 years Anatolia is the cradle of civilization. Since Hittites, different tribes, resulting with the establishment of many countries and empires, have occupied the region. Roman, Byzantine, Seljuk and Ottoman empires are the most significant civilizations in the history that had brought Anatolia to its historical structure stock. There are many churches, bridges, school, mosques, cisterns, public baths, palaces and pavilions, defying the centuries with their magnificence. Istanbul, as the capital of Byzantine and Ottoman empires has an important and special place among the other cities in Turkey with respect to cultural heritage.

As well known, Turkey is greatly exposed to seismic hazard, which causes its large and valuable buildings to be strongly at risk of severe damage or even destruction due to earthquake. This problem mostly stands for historical and monumental constructions, due to the fact that most of them frequently lack basic anti-seismic features. In one of the latest seismic event, 1999 earthquakes, 36 historical monumental structures including Fatih mosque have been damaged in Istanbul. Only this situation is enough to underline the necessity of special care for the preservation of the cultural heritage structures (Aras 2013).

Heritage structures should be passed on to future generations in its authentic state and in all its variety as an essential part of the memory of the human race. Otherwise, part of man's awareness of his own continuity will be destroyed (Amsterdam Charter, 1975). For the protection of the historical structures the best available protection strategy must be aimed. For this reason the problem must be analyzed well and the solution should be effective to provide desired safety with minimum intervention. In that respect the technological and innovative solutions should always be used, bearing the authenticity of the structure in mind. This study aims to represent innovative technologies and strategies to preserve the cultural heritage structures against earthquake effect. Recently two main applications for the preservation of the heritage structure are the strengthening and rehabilitation of dynamic properties of the systems. For the strengthening of the systems use of Fibre Reinforced Polymers became very popular strategy for the historical structures and Base Isolation technique is seen as an effective and applicable.

Great attention is paid not only to reliability and durability of intervention methods, but also to the possibility to be easily monitored and removed if required. Aiming to safeguard the existing historical structures from inappropriate restoration operations, the key parameter is named as reversible technologies. The use reversible technologies in the protection of the historical heritage buildings are also assessed briefly in this study.

EARTHQUAKES AND HISTORICAL BUILDINGS IN TURKEY

Over the course of history Anatolia has been the site of numerous destructive earthquakes. At least 70% of the region is under-risk of earthquake. Between 1902 and 2005, 128 earthquakes hit the region causing more than 80.000 deaths. The recent Van and Erciş earthquakes also confirm the destructive effects of the seismic activities in Turkey. Most of the historical documentation is related to damages suffered in Istanbul. The earthquake history of the city reveals that; it experiences with a medium earthquake (I_0 = VII – VIII) in every 50 years and with a strong earthquake (I_0 = VIII - IX) in every 300 years. Moreover recent extensive geophysical studies have clearly delineated the presence of a single major tectonic entity crossing the Marmara Sea. The probability of having an MW 7 + earthquake is in the vicinity of 70% in the next 30 years (Erdik et al 2004).

Historical structures in Turkey can be classified based on the construction material as masonry and timber structures. Masonry structures are brittle and heavy, and their substantial masses impose significant seismic loads on the walls. The typical damage in a masonry structure is in the form of a crack on load bearing structures. The depth the extent of the crack determines the severity, and failure is brittle. On the other hand, well-designed wooden structures, with timber frames and floor systems, have generally performed well in earthquakes because of the ductile nature of the wood. Failures are often due to insufficient foundation anchorage or unbraced cripple walls and soft stories. Figure 1 shows damaged masonry and timber structures under earthquake loads in Turkey (Prohitech, 2014).

Figure 1.

Figure 1.
Earthaquake damage for masonry and timber structures (*Prohitech, 2004*)

INNOVATIVE TECHNOLOGIES FOR CULTURAL HERITAGE

Any strategy, used for the rehabilitation of historical structures should have some superiority over a common one such as the efficiency of the strategy should clearly be set, the application must not disturb the cultural value of the structure and it should be reversible. Meeting these requirements needs to use the best available techniques, materials and strategies. As a result, technological developments introduce innovative products for the protection of historical buildings. An extensive literature survey has resulted with identification of different contemporary materials and method such as use of shape memory alloys, active and passive control techniques, use of fibre reinforced polymers, health monitoring techniques, use of damper braces or use of tuned mass dampers for the protection works. Apart from the others, this study aims to presents the technical details about the use of fibre reinforced polymers and base isolation techniques since they are applied to the historical buildings efficiently.

Fiber Reinforced Polymer Overlays (FRP): Structural intervention with FRP overlays is one of the most widely used strategies to upgrade the performance of masonry structures. The application increases the strength and ductility of the masonry. They can be regarded as innovative because the FRP material is new in seismic retrofitting, because it's very good mechanical characteristics and because it offers a wide range of attractive technical solutions (Calado et al. 2006; Beg et al. 2006).

There are two basic approaches to FRP strengthening of the masonry walls. The first one is the application of FRP overlays on the surface of the wall (for normal masonry walls). The second one is the application of FRP overlays on both surfaces and connecting the overlays with metallic tie rods to induce larger confinement action. FRPs are composite materials constituted by two core materials, namely fibre material with high mechanic properties and matrix acting as a binder. The role of the fibre is to resist the external loads, while the matrix has both the function of guarantying the adhesion to the support and transfer the stress: the result is a lightweight material with high strength capacity (Beg et al. 2006). A wide range of mechanical properties can be covered by selecting different types of fibre and matrix (i.e.: Young modulus and strength capacity). Commonly, fibres used for the realization of composite materials are glass, carbon and aramid fibres (Figure 2).

Figure 2.
FRP applications and stress-strain relationships (*Beg et al. 2006*)

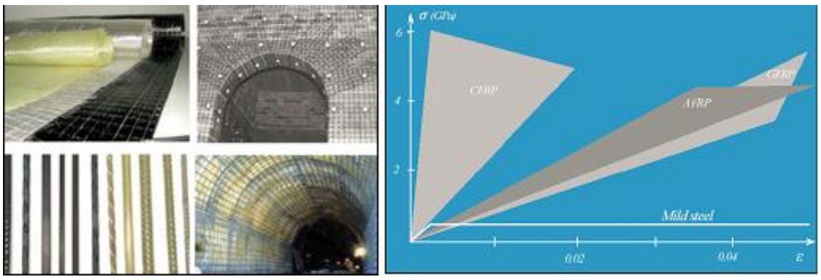

Figure 2.

In order to prove the useful effect of FRP applications many experimental studies have been carried. 1/6 scaled model of Mustafa Pasha Mosque has been tested on tri-dimensional shake table with its original and strengthened forms with FRP and the strengthened model by FRP has shown very good performance (Prohitech 2004). Figure 3 shows another experimental study to prove the application of vertical and horizontal FRP strengthening for Un-reinforced Masonry (UM) walls. Increase of strength and especially ductility is evident (Stoian et al 2003).

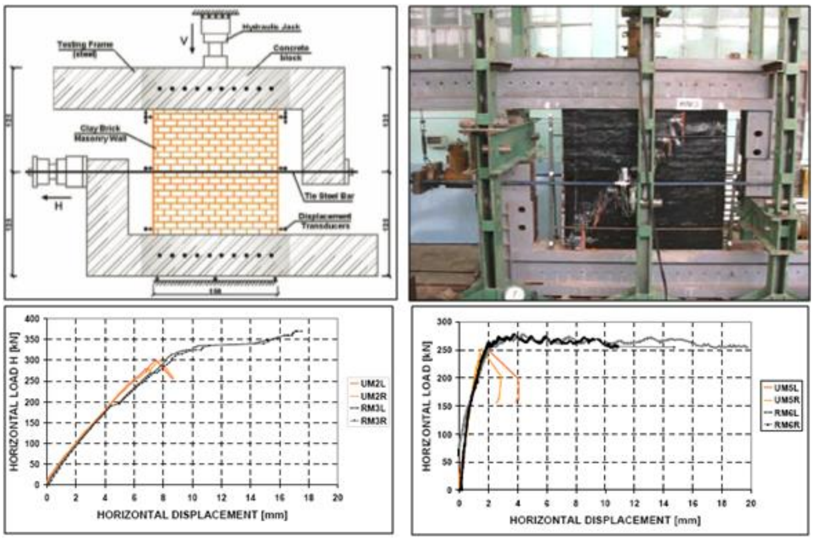

Figure 3.

Figure 3.
Experimental study of FRP strengthening (*Stoian et al 2003*).

Base Isolation: For in-plane and out of plane loading masonry walls are very stiff and brittle. Typical inter-storey drifts at the initiation of cracking are in the range of few millimeters (2-3mm). Secondly small periods in the dynamic behaviour may cause the structure to be affected from ground motion severely. For this reason, base isolation technique is one of the most effective strategies to upgrade the performance since it restrict the relative displacements of the within the wall and lengthen the period.

Isolation devices can be classified as Elastomeric Devices, High Damping Rubber Bearings (HDRB), Lead Rubber Bearings (LRB), Added Damping Rubber Bearings (ADRB), Friction Pendulum System (FPS), Sliding Devices, Flat Slider Bearings, Curved Slider Bearings, Elasto-plastic Bearings and Wire-Rope Bearings (Figure 4).

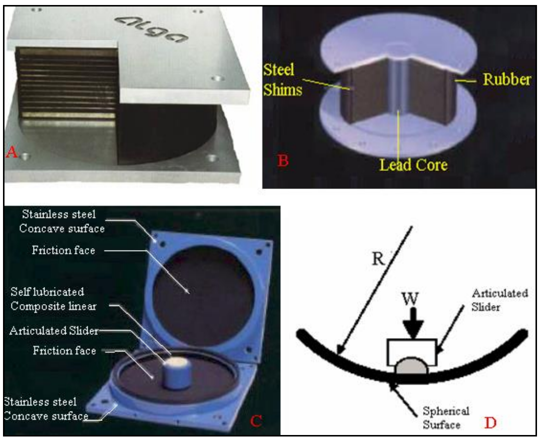

Figure 4.

Figure 4.
Base isolation devices (A : HDRB, B:LRB, C, D : FPS)

Basically, the effect of such devices is to shift the fundamental vibration period of the building upward, so as to reduce the value of the maximum spectral acceleration. For this reason seismic isolation is very appropriate for structures with short periods and low damping like masonry buildings. The devices themselves can dissipate a given amount of input energy, when these devices possess special dissipative features, or can be absorbed by additional damping devices.

The first historic structure seismically retrofitted with base isolation, the Salt Lake City and County Building, drew attention to the use of isolation for sensitive existing buildings. Later on, seismic isolation was applied to many vulnerable masonry buildings of historic significance, including the Ninth Circuit U.S. Court of Appeals building in San Francisco, Due to the possibility of efficiently improving the seismic capacity with minimal disruption to its architectural features, base isolation system has been recently suggested as an innovative retrofitting strategy (Aras and Altay 2015).

REVERSIBILITY

As a consequence, new technological systems are needed, able to provide solution not only to specific structural or architectural problems, but also aiming at improving the global performance of the construction. Similarly, great attention is paid not only to reliability and durability of intervention methods, but also to the possibility to be easily monitored and removed if required, according to the widely shared policy, aiming at the safeguard of existing buildings.

Reversible Technologies are based on the integration of structural members of different materials and/or construction methods into a single construction. The basic feature of them is that their application should be always completely recoverable, that is reversible, if required. This is considered as an essential design requirement in order to prevent historical and monumental buildings from unsuitable rehabilitation operations (Prohitech 2004).

CASE STUDY - BEYLERBEYI PALACE

As a case study earthquake performance and rehabilitation of Beylerbeyi Palace is briefly discussed in this study. Detailed information can also be found in the recompleted journal papers (Aras et al 2011; Aras and Altay, 2015).

Architectural and structural system of Beylerbeyi Palace: Beylerbeyi Palace is the largest and most elegant Ottoman palace in Asia. Great importance was given to this palace and its decorations. Figure 5 illustrates the palace with exterior appearance and interior spaces.

Figure 5.

Figure 5.
Beylerbeyi Palace (A: Exterior appearance, B, C, D: Interior spaces)

The palace consists of two main floors and a basement containing kitchens and storage rooms. In the basement floor storey heights vary between 1.5 and 2.2 m whereas in regular floors, they vary between 6 – 9 m. The building has a 72 m length along the shore and 48 m in the perpendicular direction. The total height of the structure, excluding the timber roof, can be approximated to 20.60 m. The load bearing system is mainly made of masonry walls and timber slabs. The basement floor of the palace enables to identify the masonry, which is composed of lime mortar, brick and stones. These walls are also forming the foundation system of the palace. The thickness of the walls in the basement floor is generally 1.4 meters whereas it is 80 cm in the first floor and 60 cm in the second floor of the palace. Timber slab systems constituted by oak and fir have been used. Figure 6 shows the structural masonry walls and timber slab system in the foundation of the palace.

Figure 6.

Figure 6.
Masonry walls and timber slab system in Beylerbeyi Palace

Beylerbeyi palace is used as a museum now. A damage survey, carried out in the palace has shown that, the palace is presenting the sign of earthquake-oriented damages. For this reason, the palace is investigated within the PROHITECH project.

Analyses of the Palace: Dynamic properties of Beylerbeyi Palace are identified with ambient vibration survey (AVS) and the results are used to calibrate the finite element model of the palace constructed in SAP2000-V10. Presented in another publication (Aras et al. 2011) in detail, the tuning process has resulted in three different moduli of elasticity for brick masonry in the palace (Figure 7). To determine the earthquake hazard level for Beylerbeyi Palace, the hazard maps obtained by Erdik et al. (2004) have been used. Maximum Considered Earthquake (MCE), which has 2% probability of exceedence in 50 years and approximately 2500 years of return period, has been used to check the safety of the palace. The constructed response spectrums for 2%, 5%, 10% and 20% damping ratios are illustrated in Figure 8. AVS has indicated the damping ratios are between 1 % and 2.7 % for the first eight modes of the structure.

Response spectrum analyses have been performed for both transversal and longitudinal directions. The safeties of the masonry walls, which are the main structural elements, were concerned. Figure 9 shows the horizontal stresses (S11), vertical stresses (S22) and shears stresses (S12) under Maximum Considered Earthquake for 2% damped structure. The high stress concentration regions (in yellow and green colours) are clearly seen. For horizontal stresses the upper portion of the structure is under risk. These stresses reach to 7 MPa. Obviously these S11 stress stem from the out of plane movement of the walls. The magnitudes of the vertical stresses are less than those of horizontal stresses and high stress concentrations are gathered on the lower levels as expected. Additionally wall segments between two openings are under high stress. S22 stresses are beyond 3.5 MPa. The magnitudes of shear stresses are less than that of vertical stresses. Generally its maximum value is about 1.5 MPa and on the corners of the opening shear stress concentration is observed.

Figure 7.
Numerical model of Beylerbeyi Palace before and after the modal tuning

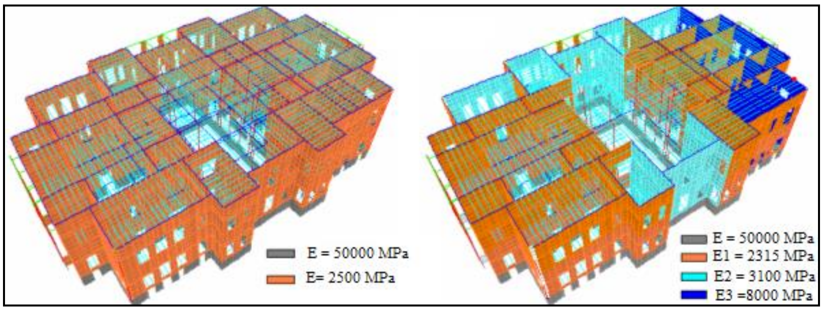

Figure 7.

Figure 8.
Response spectrum of MCE for different damping ratios

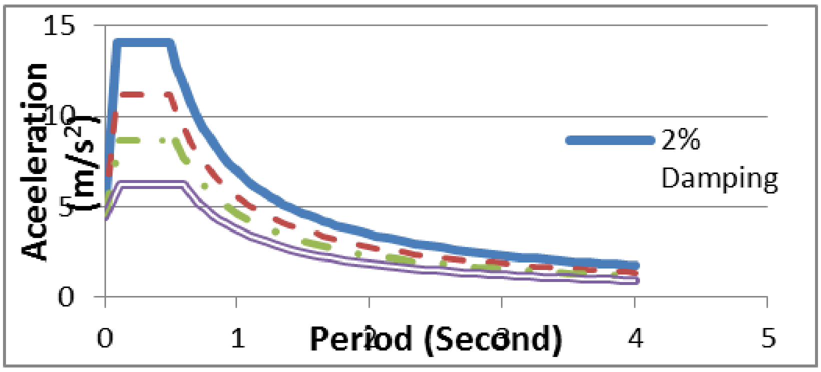

Figure 8.

The experiments over the wall and mortar specimens made in the laboratory have given the strength properties for the masonry walls in the palace as 10 MPa for compressive strength and 0.85 MPa for tensile strength. As the result of out of plane action of the walls, S11 stresses are well beyond the tension strength of the masonry. Secondly the compression stresses (S22) are less than the compressive strength of the masonry. Finally the shear stresses on the masonry walls exceed the tensile strength of the material however the shear strength of the masonry depends on the compression stress on the masonry as stated in Equation 1, where τ_{safety} is the expected lateral shear strength, τ_0 is the masonry cracking shear obtained experimentally, μ is the friction coefficient and σ is the vertical stress on the masonry wall in the system. τ_0 and μ values can be accepted as tensile strength and 0.5 respectively. Evaluation of the stress values showed that, most of the walls in the palace are safe under S12, shear stress but there are many masonry wall segments on which the shear stress exceeds the shear strength of the wall.

$$\tau_{safety} = \tau_0 + \mu \sigma \qquad (1)$$

The result of the safety evaluation has shown that, Beylerbeyi Palace is safe under vertical stresses. On the other hand horizontal and shear stresses exceed the strength parameters of the material. It can be concluded that, the structure is not capable to resist the earthquake ground motion, according to MCE.

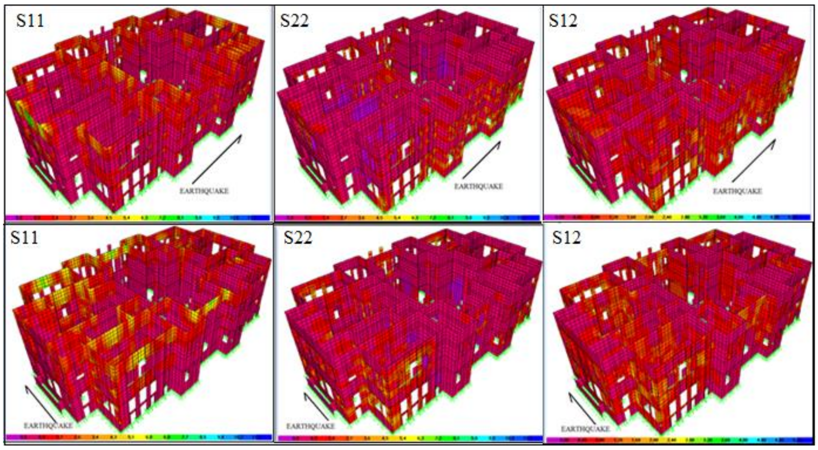

Figure 9.

Figure 9.
S11, S22 and S12 stresses under RSA of MCE for 2% damping

Strengthening of Beylerbeyi Palace with FRP: The FRP application for Beylerbeyi Palace is based on the computed horizontal and vertical tension stresses by Response Spectrum Analysis (RSA). The critical locations of the horizontal and vertical stresses were determined as the regions on which the stresses exceed the tensile strength of the masonry. (Figure 10).

For the strengthening fabrics type of FRP is appropriate because of their simple application. Main fibres of FRP fabrics should be horizontal. Horizontal fibres are effective to carry out of plane stresses on the top part of the structure. The wall between two windows can be treated as a column and it can be fully confined by FRP fabrics. These increase the vertical load capacity and ductility of the wall. MCE requires that, almost every wall should be covered by FRP. In that respect each wall in the first and second storey of the palace should be covered by FRP along with horizontal direction. Here the FRP is applied to the walls from one face. One face application is important with respect to historical and aesthetics appearance aspects of the palace.

The reversibility of composite materials is a very important aspect. These types of materials, in some cases, reach the “complete reversibility”. Composite materials using different bare materials and construction technologies can reach three different degree of reversibility (e.g. small, medium and large). The aspect that must be controlled for having a good degree of reversibility is the type of resin used (Beg et al. 2006).

Figure 10.
Critical regions of stress according to MCE

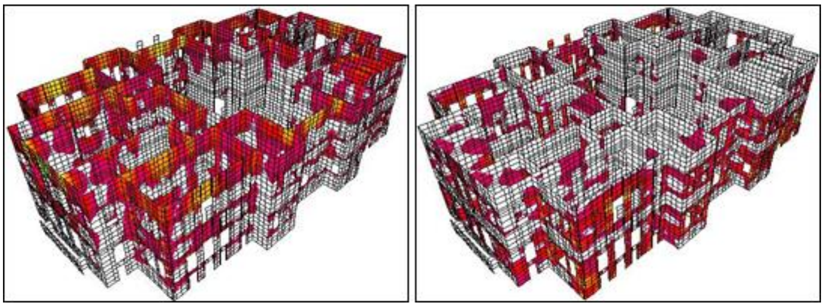

Figure 10.

In case Beylerbeyi Palace, it was noted that the walls are covered from one face. This requirement is very important with respect to aesthetic appearance. For the external walls, FRP can be applied between küfeki stone façade and masonry walls. In that condition all application would be hidden. For the internal walls the stucco plaster is in main concern and application side of the wall depends on this covering. For the timber-covered room FRP can be applied underneath the timber surface. Finally for normal plastered walls there is no problem since plaster can be applied over the FRP application.

Rehabilitation of Beylerbeyi palace with base isolation: Dynamic modes of Beylerbeyi Palace showed that; the first 44 modal frequencies of 60 modes are on the flat plateau of the response spectrum. For this reason shifting the fundamental periods is going to result in significant reduction in spectral acceleration. Secondly the small damping ratio of the existing palace is another source deficiency. In these respects, High Damping Rubber Bearing (HDRB) is preferred to isolate the structure.

The isolation devices are planned to be inserted in basement walls of the palace since the basement walls are also suitable to insert the isolators with respect to safety and historical texture concerns. The isolator should be distributed to the plan of the structure in a way that it does not disturb the load flow and cause torsional behavior. The selected distribution of the devices is shown in Figure 11-A. Total number of bearing is determined as 123. Isolator design for the palace has been done according to the procedure defined in Yang et al. (2002) and FEMA 302 (1997). Details of the procedure have been presented in another study (Aras and Altay, 2015) and designed HDRB device is illustrated in Figure 11-B. The diameter of the circular elastomeric portion of the device was determined as 90 cm and 13 rubber layers of 12 mm thickness were used. The steel plate thickness was determined as 2 mm. Finally, two rectangular steel plates (1 m * 1 m) with a thickness of 3.5 cm have been used on the top and bottom-side of the isolator. Figure 11-C shows the insertion of the devices to the structure.

Response Spectrum Analysis (RSA) has investigated the efficiency of the base isolation. The numerical model was revised to contain the determined device properties. The response spectrum, used for the isolated model, has also been revised according to effective damping of isolator (Figure 8). The application of isolation has altered the overall behaviour of the structure significantly. Mode shapes of the structure turned to simple rigid body motions with a period of 2 second. Figure 12 shows the S11stress values, which was the maximum stresses, for the isolated Beylerbeyi Palace under MCE for two orthogonal directions. The stress values have been reduced significantly under maximum considered earthquake.

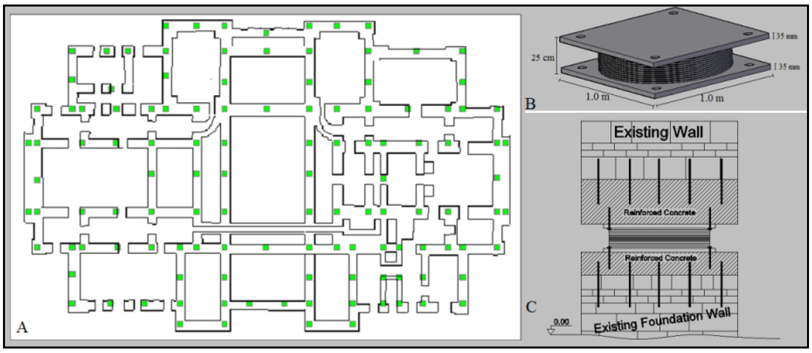

Figure 11.

Figure 11.
Details of HDRB application in Beylerbeyi Palace

The proposed base isolation strategy, at the level of foundation, is an irreversible intervention. Reversibility means the ability to undo the change without harming the original structure. Although base isolation intervention is irreversible, it does not touch the historic fabric of the palace and other historical resources.

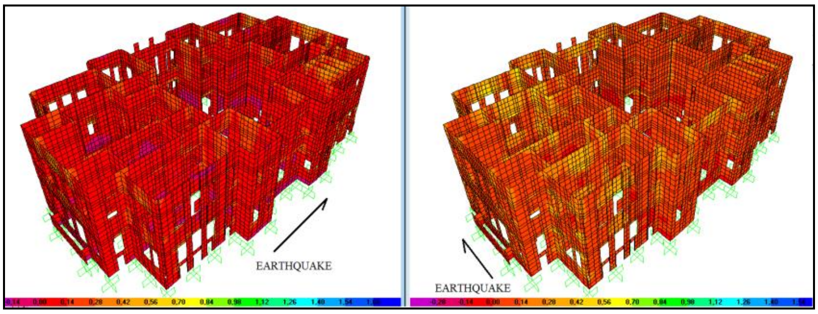

Figure 12.

Figure 12.
S11 stresses under MCE for isolated Beylerbeyi Palace with HDRB

The proposed intervention is limited to the foundation level of the building. The facade and the interior characteristics, including frescoes, paintings and other architectural elements are fully preserved. Application of base isolation system also requires the separation of the palace by a 25 cm gap from its surrounding to ensure the serviceability after expected earthquakes. Moreover all lifelines, ducts and the other required links must be connected to the palace via flexible connections.

CONCLUSION

Importance of the historical structures and preservation of them from earthquake ground shaking is outlined in this study. For the preservation the use innovative strategies, namely use of fibre reinforced polymers and base isolation techniques investigated in detail. Moreover the reversibility concept and its key role in the preservation are explained.

As a case study, one of the most important structures in Istanbul, Beylerbeyi Palace has been investigated. The earthquake performance of the palace is found inadequate. Strengthening of the palace with FRP and rehabilitation of the dynamic properties by the application of base isolation techniques has been investigated. It is shown that the earthquake safety of the palace can be ensured by the strategies without damaging the palace's historical authenticity.

REFERENCES

-Amsterdam Charter, (1975). "The declaration of Amsterdam, Congress on the European Architectural Heritage", Amsterdam.

-Aras, F. (2013). "Istanbul'un kültürel mirası ve maruz kaldığı tehlikeler", XVII. Oratçağ Türk Dönemi Kazıları ve Sanat Tarihi Araştırmaları Sempozyumu, İstanbul.

-Aras, F., Krstevska, L., Altay, G. and Taskov, L. (2011). "Experimental and numerical modal analyses of a historical masonry palace". Constr Build Mat. 25:81-91

-Aras, F. and Altay, G. (2015). "Seismic evaluation and structural control of the historical Beylerbeyi Palace". Struct. Control Health Monit, 22(2): 347 – 364.

-Beg, D., Skuber, p. and Pavlovcic, L. (2006). "Set-up of advanced Reversible Mixed Technologies for Seismic Protection", Prohitech, WP6, Ljubljana.

-Calado, L., Proença J.M. and Panão, A. (2006). "Innovative materials and techniques for seismic protection", Prohitech, WP5, Lisbon.

-Erdik, M., Demircioglu, M., Sesetyan, K., Durukal, E., Siyahi, B. (2004). "Earthquake hazard in Marmara Region, Turkey". Soil Dynamics and Earthquake Engineering 24:605-631.

-FEMA-302. (1997). "NEHRP recommended provisions for seismic regulations for new buildings and other structures", Building Seismic Safety Council, Washington.

-Prohitech (2004). “Earthquake protection of historical structures by reversible mixed technologies”, FP6-2002-INCO-MPC-1.

-SAP2000. 2006. “Structural Analysis Program”, Berkeley, California.

-Stoian, V., Nagy-György, T., Dan, D. and Gergely, J. (2003). “Retrofitting the Shear Capacity of the Masonry Walls Using CFRP Composite Overlays”, International Conference in Earthquake Engineering, Skopje, Macedonia.

-Yang, Y.B., Chang, K.C. and Yau J.D. (2002). “Earthquake Engineering Handbook”, Chapter 17: Base Isolation, CRC Press Boca Raton, Florida.

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FORM-FINDING WITH EXPERIMENTATION ON NATURAL PERIODIC FORCES: THE SOUND MOTION STREAKS PROJECT

Pınar Çalışır

Abstract

Today, many computational techniques of form-finding use the term design with the term research. Thus, architectural studios become more and more like laboratories for design experiments. This study proposes a design experiment called "The Sound Motion Streaks Project" where the sound can be used as generative computational data and applied to digital form finding studies. Design process relies on an idea that sound as an external force can produce or deform shapes according to its influence. The first phase of the process is to make

Keywords: Form-finding, Kinetic Form, Sound, Experimentation

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physical experiments on the sound and see its influences on granular and fluid materials. We can say that, in these physical experimentations, there is a knowledge transmission from physical to digital medium that we can use as design parameters on software. In digital software, the sound can be a force field and manipulate digital matters such as particles, curves and meshes. The form-finding method of the Sound Motion Project is constituted by all physical and digital experiments, and applied in an urban area in order to discuss its architectural potentials. For instance, all material events in the area depend on duration and movement of digital tools, thus the notion of form and/or space become kinetic. Kinetic reactions bring out a new understanding of space and form which consists of motionless boundary, translatability, rhythmicity, differentiated densities and heterogeneity. Also this generative approach gives architects many potential solutions for architectural forms.

1. INTRODUCTION

Experimentation is the most important parameter for a scientific discovery. What about discoveries of forms in architecture? Nature has a lot of novel forms and patterns and produces new ones without stopping a moment. Thus, it is not a coincidence that the novel ideas in architecture usually come from experimentation procedures copying the processes of nature. To do this, architects need to understand how nature finds her forms and what her rules during the process of form generation. Our motivation in this study is a desire to create a form finding process called "the Sound Motion Streaks Method" in terms of experimentation on natural forces in order to find novel forms in architecture. The Sound is a natural force that we used in our study. The main objective of using sound is to see what sound looks like through interaction with matters. By doing this, we can produce a new notion of space which differentiates from the traditional Euclidian space and create a multi-sensory experience on users with the help of sound materialization. Throughout the paper, audience will see that there is no starting shape in this process, but there are different raw materials reacting to the sound influences. Therefore, this kind of formation processes will lead us to create a variety of topological geometry. Spaces emerging in this process are no longer static but dynamic, and this dynamism in the structure brings some kinetic properties to the form. In an animated form, the notion of "kinetic" reveals with a continuous motion through immovable structure of form. We can see the history of material movement under the influence of sound through transparent and overlapping structures of form. This illusion of movement called as "a frozen moment" and the designer becomes a person who "orchestrates" the whole process (Terzidis, 2003). The design process in this study is developed in four stages. First stage is to gain a general knowledge about the notion of form-finding process and physical sound properties. In this stage, additional to the literature review, we repeated physical sound experiments from the precedents -such as Cymatics- in order to strength our understanding of sound properties and material interactions. The second stage is to use this general knowledge coming from the first stage and constitute various digital experiments to examine the nature of digital materials and their reactions to the sound. Third stage is to generate our form-finding method and test it with different parameters in order to find a way for creating an urban scale prototype. Our final stage is to test this method in an urban area and discuss its architectural potentials through this way.

2. UNDERSTANDING THE TERM FORM-FINDING AND THE SOUND PHENOMENA

2.1. Form-Finding

In 1806 Goethe introduced the term "Morphology". He has a unique understanding on how forms emerge in nature and how the constant formation and transformation of forms related to environmental forces (Menges&Ahlquist, 2011). According to him generative processes in nature affect both organic and inorganic systems with the help of natural forces. He invented "Ur-forms" in order to explain "the foundational programs" in nature. These programs determine differences and similarities between forms in nature which is to say that similar forms (Urforms) should share a common foundational program (Aranda&Lasch, 2006). These foundational systems actually refer environmental forces which affect all forms in nature and cause a constant transformation throughout its lifetime. For instance, imagine different cracking systems in nature. The foundational program behind dry mud and dry paint is the same, therefore these cracking systems looks like identical. They are "Urforms". Both are shaped by same environmental force which is "fluvial erosion" (Aranda&Lasch, 2006). D'Arcy Thompson explained similar ideas with Goethe in his book "On Growth and Form" in 1917. He proposed that there are environmental (external) forces in nature affecting shape of things. More importantly, he believed that we can solve this process with mathematics (Menges, Ahlquist, 2011). Similarly, Philip Ball (1999) stated that patterns and forms in nature are not only generated through biological coding, but also there are simple physical laws behind them. Therefore, we can repeat complex forms in nature by repeating these rules. From all these ideas, we can say that there are some natural forces in the world and they are acting on organic and inorganic things and determine their appearances. These external forces cause similarities and differences and we can repeat their effect on forms by repeating these physical forces. In the Sound Motion Streaks Project, our departure point is to use sound as an external force and find sound patterns and structures by means of form and force relations. Therefore, in the next chapter we examine some precedents works on sound phenomena and repeat some of their experiments in order to find the foundational program behind sound patterns and forms.

2.2. Sound Properties

To understand periodicity of sound we should understand the properties that create rhythmic vibrations. Sound is a kind of wave which passes through the air effecting particles back and forth and change their equilibrium positions, but it is the disturbance which travels not the individual particles in the medium [1]. The frequency is the number of occurrences of a repeating event (period) per unit time. The amplitude is the measure of a magnitude (energy transported) of oscillation of a wave [2]. If we find a sound analysis of a particular sound, we can see that, both amplitude and frequency reflects the periodicity of sound and rhythmicity (Figure 1).

Figure 1. Nuthatch Sound Analysis: The image above illustrates the amplitude; the image below represents the frequency accordinf to time. (*Raven Pro 1.5 Beta*).

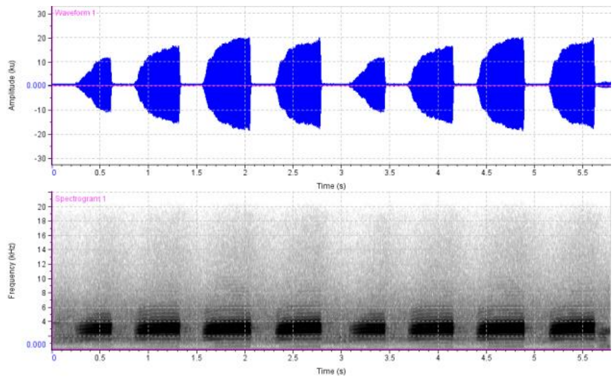

Figure 1

2.3. Sound as a Natural Phenomenon

Nature consists of complex systems constantly changing one assemblage of conditions to another-opposite one. These changing systems –animate or inanimate- create their own repetitive patterns and forms and their formation reveals hidden periodic forces which lay beneath them. A continual state of "vibration, oscillation, undulation and pulsation" gives these forces periodicity (Jenny, 2001). On the basis of vibrational phenomena, sound can be seen as another example. Taking information from its nature cannot be done with an eye or other senses except hearing. However, this does not give any visual data on the periodicity of the sound. Thus, since the eighteenth century, scientists have worked to make sound visible in order to explore its nature (Jenny, 2001). Ernest Chladni (1756-1827), who was one of the first physicist musicians, tried to simulate the vibrations of sound and make it visible. Chladni used a violin to vibrate metal plates covered with powder, and made the sound vibration process visible (Jenny, 2001). After Chladni, one of the important persons working in this area was Hans Jenny, a physician and natural scientist who founded Cymatics, which is a study of the vibrational character of sound and its hidden force on matters. Jenny's (2001) experiments, by putting matters such as sand, fluid, powder or salt on a metal plate, showed the hidden force of the sound on materials(Figure 2). He observed that in a kinetic-dynamic process based on sound vibrations, all patterned formations are generated and maintained by sound periodicity (Jenny, 2001). Overall, according to Jenny (2001), sound is physical force that can create vibrations and finally systemized pattern forms.

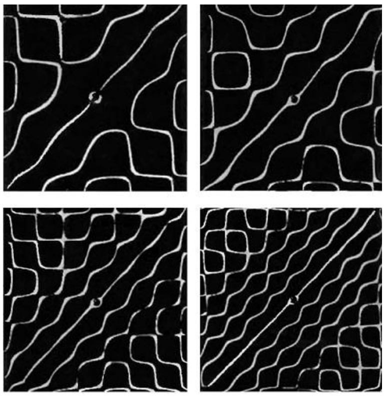

Figure 2

Figure 2. Chladni Experiments in Cymatics (Sand on a steel plate). Same topology of patterns emerges but numbers of patterns are growing as the pitch goes up. (*Jenny, 2001*).

2.4. Physical Experiments to Make Sound Visible

In this phase of the study, multiple physical experiments were generated from the Cymatics experiments, in order to deeply understand which parameters of sound actually create forms, deform shapes, or produce patterns. Water, non-Newtonian fluid made from water and starch and salt were used for physical experiments.

In experiment 1 and 2 (Figure 3), 40x40cm steel plates were used in order to materialize sound wave patterns. The left image shows the 1mm thick plate and the right image shows the 0.5mm plate. These square plates were clamped by the center with a speaker connected with an amplifier. Salt was sprinkled onto plates vibrating with sounds in different frequencies starting from 20Hz and gradually increasing to 80Hz with the help of the amplifier. As the plate vibrates, the salt begins to travel along the surface and salt particles interact with each other until they reach points along the plate that salt particles are not vibrating. These non-vibrating areas can be called as accumulation zones. We can see these zones as white lines on plates. When thickness of the plate increases, patterns on the surface blur, so that in the right image in Figure 3, we can see clearer patterns with a 0.5mm thick plate. Ultimately, every frequency has its own 2d pattern because of its unique vibrational character.

Figure 3. Experiment 1 and 2; Chladni Experiments. 1mm thick plate on the left and 0.5mm thick plate on the right. In both images, each pattern belongs to a particular frequency. Frequency used in these experiment starts from 200Hz and goes until 800 Hz. Material: Salt (*Calisir, 2012*).

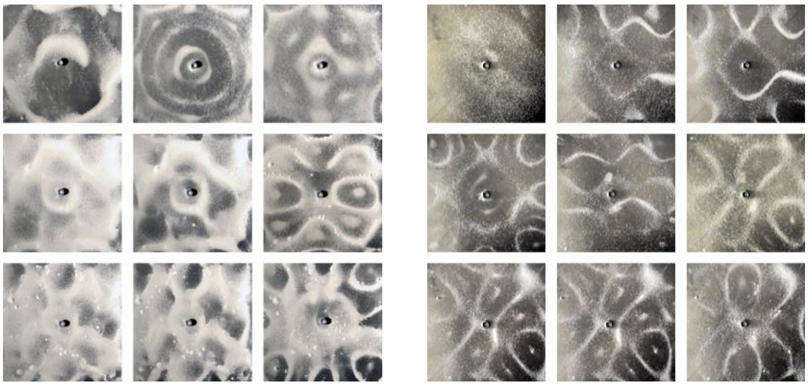

Figure 3

In experiment 3 (Figure 4 - left image), we used corn-starch and water to experiment on a viscous fluid affected by a sound vibrations. This Non-Newtonian fluid behaves against the gravity and dances with the frequency played on the speaker. By the means of material behavior, viscous nature of the fluid tends to provide its surface continuity but irregularity of fluid molecules help to create 3d forms and patterns. Thus, this material has the capacity to create volumetric forms and patterns. In experiment 4 (Figure 4 - right image), we repeated previous experiment with water. Water maintains it surface continuity, therefore, it does not produce split patterns or 3d forms, instead the sound only can deform its surface. The higher frequency brings out the more complex wave-patterns.

Figure 4. Experiment 3: Non-Newtonian Fluid on the left image. Experiment 4: Water on the right image. Water experiment illustrates different frequency patterns between 200Hz to 800 Hz. On the contrary, in experiment 3, the whole motion emerges with a constant frequency-200 Hz. (*Calisir, 2012*).

Figure 4

These experiments are important in order to understand different material behaviors against sound vibrations and find a process to materialize sound. For fluids, viscosity determines the embodiment of matter. On the other hand, granular materials are more interactive inside because of their particular nature. In the most general sense, sound frequency and amplitude stimulate matters, which cover a plate connected to a sound generator. However, the time and material features are also minor effects in producing the overall shape. Because materials have either viscosity or a granular system, they continue to change through more complex and heterogeneous formations over time until the process is over. From these physical experiments, three fundamental issues can be observed. First one is the behavior of natural force, the second one is material behavior and the third one is material capacity.

The digital medium is a place for representing natural world, obviously with the control of a human. Therefore, digital materials are always open to manipulation and sometimes we cannot foresee material behaviors. Thus, in order to build a form-finding system digitally, we have to create simulations and understand same principles in physical experiments in terms of digital matter. Therefore, findings coming from physical experiments become a guide for digital ones in this study.

3. DIGITAL EXPERIMENTS TO SIMULATE PHYSICAL DATA

From physical experiments, we know that sound spreads in the environment as a wave. Also, sound source produces rhythmic and periodic forces when it meets a surface. If there are particles upon the surface, they react to the sound force. These findings help us to constitute digital models of physical experiments in Autodesk Maya. In order to create an influence of sound amplitude or frequency as a dynamic force field in the Autodesk Maya, the Audio Wave node, which can read sound amplitude per second, was used. A dynamic force field is a force that manipulates digital matters such as particles, fluids, or polygons by pushing, pulling, splitting and so forth. Through the Hyper Shade (Figure 6), which is a relationship editor on Maya, dynamic connections between materials and forces in the scene can be controlled during the time.

Unlike physical experiments, both particles and fluids can be simulated through this process at higher level because the unpredictable behaviors of both materials can be kept under control. Hence, the digital process allows further evolution of forms and assemblies. From this understanding, the first digital experiment (Figure 5-left) was built in Autodesk Maya. There was a sound source in a container producing sound waves according to sound amplitude and particles in this container not only reacted to this periodic force but also to each other. Therefore, this system produced well-organized and regular patterns. More interaction between particles and higher amplitude caused more complex patterns. Second experiment (Figure 5-center) illustrates the surface deform behavior of sound from physical experiments and applies it upon continuous surfaces such as a sphere. Thus, sound active surfaces emerge. Third experiment (Figure 5-right) demonstrates the form generator features of the sound wave and produces volumetric forms within the harmony with sound amplitude.

Figure 5

Figure 5. Digital experiments: Left image: Sound becomes a Pattern Generator when it interacts with particles. Center image: Sound becomes a Surface Deformer with a continuous surface. Right image: Sound becomes a Form Generator with viscous fluids. We can see sound effects on different digital matters.
(*Calisir, 2012*).

According to these experiments, we can say that in digital medium (Maya) sound can generate patterns and become "Patterns Generator", deform existing shapes and become "Surface Deformer" and finally generate forms and become "Form Generator". Analyzing and synthesizing both physical and digital experiments help to create our own system which is the Sound Motion Streaks Project.

4. CONSTITUTING THE SOUND MOTION STREAKS METHOD

Learning from physical experimentation provides a deep understanding of sound and its nature. On the other hand, digital simulations of physical experiments provide a deep insight of how digital matters react to the sound when it is simulated by a dynamic force field as a wave. From these experiments, we construct knowledge on digital material behaviors and capacities and create our form-finding tool with the integration of different kinds of digital materials. There are several ways to create forms by taking information from sound and manipulating time. For instance, the Audio Node can be connected to particle emitters in order to change the quantity of particles released per second or manipulate their directions and scale. On the other hand, this process can be stated in terms of the logic of constructing linear elements produced by particle tracing and apply particle releasing based on curvatures. In order to get more control over the particle system, each particle converted into polygonal meshes, therefore, this new converted matter creates multiple structural formations. This mesh form has much more characteristic than the other, which is only created by particles. In the Sound Motion Streaks Method, three different digital tools are regulated together: the particle system, the linear curve system and the polygonal mesh system. Together the entire system fulfils its performative capacity with regard to these three systems. Spatial conditions have different levels of density. More articulated and characterized spatial shapes can be produced. Additionally, for the larger scale, architectural systems have the ability of response to multiple functional requirements in the site context.

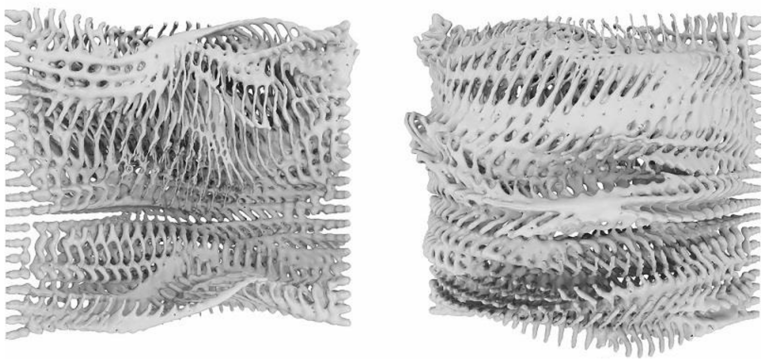

Figure 6

Figure 6. Elevations of the Sound Motion Streaks Project. In this test, a square boundary is created for the system. We can see the whole process of animation along the form.
(*Calisir, 2012*).

As hinted above, there are several ways to simulate sound driving forms in software applications, and it is a broadly acknowledged fact that software applications can cause coincidence results during the design process. To prevent this, it is necessary to understand the logic of the tools used and parameters that affect digital models. Hence, the following will focus on settings for 'the sound motion streaks method' in order to deeply understand the system, its architectural quality and make it a design tool.

4.1. Settings for Form Generation Method

As introduced above, the sound motion streaks method is based on three criteria: particles, curves and polygonal mesh. Particles are basically points that represent a collection of dots behaving like granular systems. Force fields such as air and gravity manipulate and organize this system based on the expressions or parameters. Similarly, a curve system lets one create dynamic curves so that natural movements and collisions can be created. Finally, polygons are a geometrical type that can be used to create three-dimensional structures in order to produce surface or architectural skin covering the systems.

Figure 7. Hyper Shade: Dynamic Relationship Editor. We can see connections on Hyper Shade for the Sound Motion Streaks Method on Autodesk Maya. We can change relations between digital matters and dynamic force fields through Hyper Shade.
(*Calisir, 2012*).

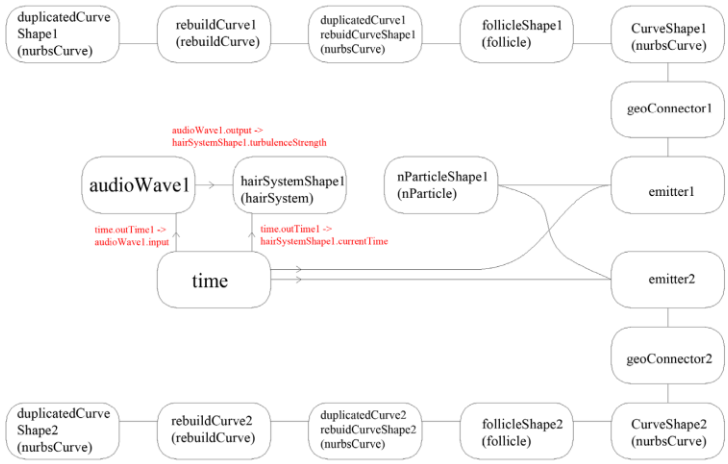

Figure 7

The whole system behaves like natural forms and like all forms in nature, they assemble themselves and also have the ability to gather their matter and interact with the environment under gravity or different fields. On the other hand, in order to produce these forms, the system must be run in a simulation. Simulations are essential for laying out complex architectural systems, in software applications and examining their behavior over extended periods of time. Also, simulations provide generative design processes (Hensel et al, 2010) and take advantage of motion movement and time. We can control dynamic relations between digital matters, dynamic force fields and time through Hyper Shade Editor (Figure 6). In order to discuss the potentials of the Sound Motion Streaks Method by the means of space and form we apply this method in an urban area.

Figure 8. This image illustrates different phases of form evolution. Time manipulation gives us a chance to freeze the moment and materialize a specific time.
(*Calisir, 2012*).

Figure 8

5. AN URBAN SCALE PROTOTYPE

For an urban scale prototype, an old bridge in Limehouse in London was chosen (Figure 8). The bridge is a kind of extension for Dockland Light Railways(DLR), but now is neglected and separated from DLR from a barrier. The whole area is affected by the rhythmic noise of DLR (Figure 9).

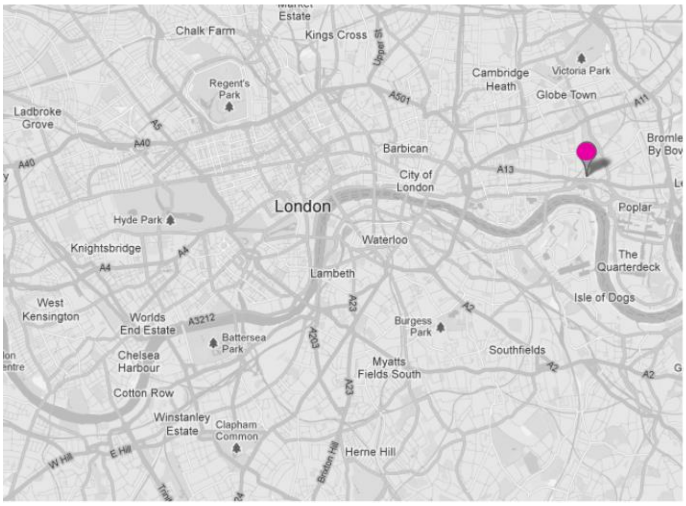

Figure 9. The city map of London. City center and Limehouse Neighborhood location .

Figure 9

In order to make visible the sound-scape of this area-a sound that is unique to an area- and produce sonic awareness, the sounds of this particular site in London were recorded and translated into an architectural proposal. The idea is to "see what the sound looks like in a particular place" and through this, to provoke a multi-sensory experience in the user.

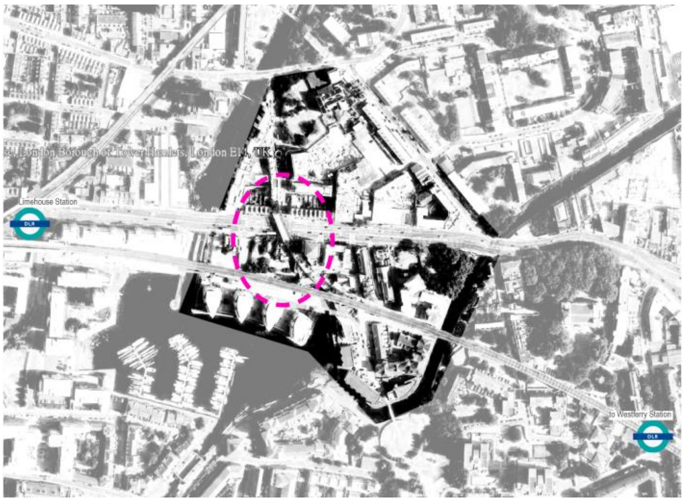

Figure 10. Google Earth İmage of Limehouse Area. Dashed line represents the neglegted bridge and its surrounding area.

Figure 10

The proposal is an urban path and connector between two different "sound areas" and making use of an abandoned rail bridge, this construction crosses a busy road to a quiet area behind the new railways. To make possible the sound visualization, the sound was captured and recorded on real time. It means that the sounds used in this proposal, present the exact differentiation of the noise/calm areas as they were captured along the path. For the urban prototype we do not fix curves in the space, instead, the sound curves travel following the path, and are influenced in accordance to the area they are passing.

This form extends in a linear site, and unfolds as a vault that varies with the urban sound. The resulting form is dynamic with differentiation of spaces, densities and textures. The linearity is broke were the sound is higher because higher sound creates voids between the layers that could be used to accommodate internal spaces. The spaces are articulated with the continuity of the shape, as a linear and kinetic space, encourages the user to flow along it. The sound as the creator of the space is frozen in time and allows the user to witness and become aware of the acoustic environment. Wall, roof, and floor are all blend together, giving a sense of continuous space and enhanced perceptual experience. Nothing in this form is predictable; everything is opened to be discovered by the self-experience.

Figure 11. An Urban Scale Prototype: Elevations. Different elevations show the whole path adaptation to the different sound areas. Linear parts are in the calm areas and volumetric parts reflect areas with higher voice.
(*Calisir, 2012*).

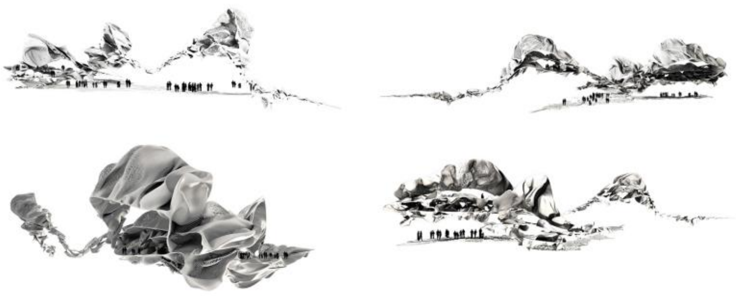

Figure 11

6. DISCUSSION/ARCHITECTURAL CONSEQUENCES

It became clear that all kinds of patterns and forms are being manufactured by not only frequency and amplitude but a generative design method which also incorporates time and the site context. All these parameters pose advance settings for digital control systems which evoke three-dimensional and responsive architectural forms (Lally and Young, 2007). Therefore, this kind of digital production of form is more sufficient and yields a variety of topological geometry. Also, what is worth noting here is the creation of kinetic space in addition to time and to give more architectural features to forms. Before going further, it is necessary to define the term kinetic. Kinetic is a term that can be expressed with the word motion in most cases. The term "motion" is a process of changing position or place over time (Terzidis, 2003). According to Terzidis (2003), "while time is involved in motion as a measurement of change, the form itself does not involve time. Thus, the kinetic form represents a motionless boundary and an extension of the notion of architectural form."

6.1. The Term Kinetic in Art and Architecture

Before architecture, the kinetic had a long history in the art, especially after the 1950s when it was used in the movement of kinetic art (Terzidis, 2003). The history of kinetic art begins with the realist manifesto published in Moscow in 1920 by Gabo and Pevsner. They proposed that the traditional elements of plastic and pictorial arts are denied and that in these arts, a new element, the kinetic rhythms, will be claimed as the basic forms of our perception of real time (Rickey, 1963). Marcel Duchamp's sculpture Mobile wheel and his painting Nude Descending the Staircase can be given as examples. These art pieces are not three-dimensional but four-dimensional which is time as an interpretation of the actual movement (Rickey, 1963).

In architecture, on the other hand, the representation of motion is usually achieved with an abstract formal arrangement which depends on the relation between "cause and effect". Cause and effect relations can be created by different digital tools and simulations. Digital tools can be animated in simulations which are essential for not only designing kinetic processes but also for designing complex material systems and for analyzing their behavior over extended periods of time. Air, sound, wave and nuclear physics are commonly available simulations (Hensel et al, 2010). Another simulation that has been mentioned so far is sound. The movement in the sound motion streaks process is provided by Audio Node and its connection with time. Small variations in the Audio Node in each sequence may produce changes in the development of each component at many different scales. Hence, as time goes on, architectural form continues emerging through much more complex and articulated space. Terzidis (2003) posited that in this complexity of form, users' eye can catch the virtual movement and the physical stimuli which forms have. Furthermore, from all digital experiments, it can be said that apart from the complexity of kinetic form, all shapes driven by sound have in common rhythmicity, motionless boundaries and changeability over time, no matter their different materials, causes or functional mechanisms. Therefore, in this design process, form is literally a product of matter. It is actually an abstract entity to which process gives certain geometric and kinetic characteristics (Terzidis, 2003).

Kinetic form evokes generative processes and the concepts of interactivity, modifiability and continuous evolution with the help of time (Tierney, 2007). In terms of time, kinetic forms produced by sound change over time and this motion either freezes the moment or makes complete. In both ways, kinetic form has great architectural value because it consists of agitated surfaces, compressed planes and penetrated spaces in both ways. Even though movement is frozen, the unique characteristic of architectural space remain; that is both dynamic and static (Terzidis, 2003). According to Terzidis (2003), it is dynamic because the design process provides an elastic essence and manipulation of entities. It becomes static when it has to freeze in order to be built. Therefore, it contains a large collection of forms from which architects find the most suitable in terms of function, architectural space and environmental context.

Figure 12. An Urban Scale Prototype. A view from surface. Voids break the linearity of the path and create internal spaces. (*Calisir, 2012*).

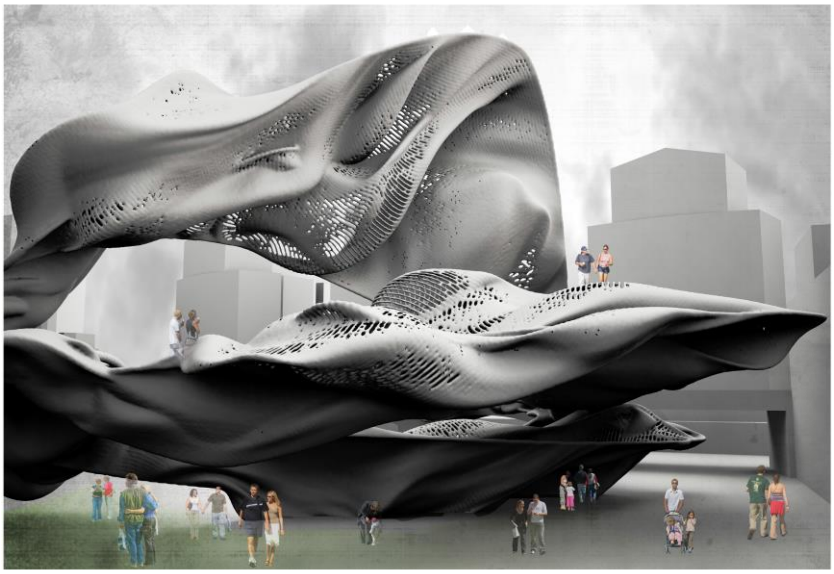

Figure 12

6.2. Conclusion

This paper proposes a method to create forms and patterns in a dynamic-kinetic process by using sound as an external force. To create this method, first physical, then digital experiments are done to understand the sound phenomena and its influence on materials. After these phases, we construct our method with 3 different tools in Autodesk Maya-curves, particles and polygonal mesh-. Sound affects this hybrid material system and we manipulate time-sound and material properties through Hyper Shade. The ultimate form emerging in this process depends on time therefore we can track the whole process along the form and this brings kinetic properties to spaces created in the Sound Motion Streaks Project. The value of this kinetic process is its changeability and endless topology. Moreover, in this animated space, users discover sound with their eyes and become aware of the sound-scape of the area. Through this multi-sensory experience, users can not only hear the sound in the environment but also see and touch therefore, the perceptual experiences are enriched and enhance.

ACKNOWLEDGEMENTS/NOTES (Cambria 11, Bold)

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REFERENCES

Aranda, B. and Lasch, C. (2006). *Pamphlet Architecture 27: Tooling*. New York: Princeton Architectural Press.

Ball, P. (1999). *The Self Made Tapestry*. Oxford : Oxford University Press.

Calisir, P. (2012). *Architectural Kinetic Forms and Sound: Emergence of Architectural Kinetic Space Driven by Sound*. Master Thesis, University College of London.

Hensel, M. and Menges, A. and Weinstock, M. (2010). *Emergent Technologies and Design: Towards a Biological Paradigm for Architecture*. New York: Routledge.

Jenny, H. (2001). *Cymatics*. San Francisco :Macromedia Press.

Lally, S. and Young, J. (2007). *Softspace.* New York: Taylor and Francis.

Menges, A. and Ahlquist, S. (2011). *Computational Design Thinking*. Sussex :Wiley Publication.

Kiendl, A. (2008). *Informal Architecture: Space and Contemporary Culture*. London: Blockdog.

Rickey, G.W. (1963). "The Morphology of Movement: A Study of Kinetic Art". *Art Journal*, vol.22, no.4, summer: pp. 220-231.

Terzidis, K. (2003). *Expressive Form*. London: Spon Press.

Tierney, T. (2007). *Abstract Space: Beneath the Media Surface*. New York: Taylor and Francis.

[1] http://www.acs.psu.edu/drussell/demos.html

[2] http://www.physicsclassroom.com/class/sound

Software Using:
Autodesk Maya
Raven Pro 1.5 Beta Version: Interactive Sound Analysis Software

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INNOVATIVE APPROACHES IN ARCHITECTURE AND PLANNING. THE FUTURE OF OUR PAST

Dr. Bouzid BOUDIAF

Abstract

Historic Arab cities show a variety of origins and modernization patterns; these were conditioned on the one hand by external factors such as pre-existing settlements, deliberate locational choices and prevailing dynastic modernization and transformation, on the other hand by internal factors such as the morphological principles implied in

Keywords:
Architecture, Culture, Urban design, Conservation, Sustainability

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individual architecture components and in genesis of the urban environment.
In this paper, we will try to highlight the socio-cultural aspects in the city structure context and their relations to the city morphology referring to the underlying shaping forces of urban form which, drawing on related, deep-rooted human attitudes, constitute the real agents of physical manifestation and are source of the non-material qualities transpiring through materials expressions.
This presentation seeks to understand the significance of the city structure in different dimensions of urban environment. Understanding the interaction between underlying political, economic, socio-cultural forces as deep structure elements is an important aspect of research objectives. This paper also studies how physical or functional changes follow changes in the underlying forces among the modernization process and city structure regeneration.
The approach to the research objectives is based on two methodologies:
• Deductive: a theoretical investigation based on the properties of the city structure, definitions, principles of design, and the dilemma of achieving modernization is as much cultural as technical. This combines information from literature reviews and the ideas of key figures in the urban development field and the place-identity, social identity and identity process as theories for cultural models of the city.
• Inductive: a study of Algiers as example of historical settlements that have undergone much change processes. The study looks to elicit the images of the city main structure to support the theoretical propositions of surface and deep structural city elements. The conclusion to this part is based on an analysis of the case study.
The research concludes its conclusion through the theoretical and empirical work
the socio- cultural aspect in the modernization process as a board and complex field.
Moreover, it introduces the concept of City Structure as a new way to envisage urban Conservation studies.

INTRODUCTION

The last decade of the XX century was marked by deep economical and political changes provoking some irreversible transformations in the socio cultural organization and the physical structure. These changes can be explained by the failure of the economical models on which were worked out the different policies of development and principles of growth and management.

The economic models of Ford and Keynes were replaced by the new economical order, which is characterized by a new economical logic based on the accumulation of the capital. This new order led implicitly to the process of restructuring economy through the emphasis of the specialization and the flexibility. Implicitly this new order led Algeria to readjust the political and economical environments in the hope to be in adequacy with the project of globalization. This readjustment is based on the rationality, and is materialized through the management of the human resources and the territorial planning at different scales and levels.

In 1997, the Algerian population reached 30 millions, a figure which is expected to rise by another 5 millions by the year 2010. More than 50% of the population is living in cities (Algiers alone represents almost 20% of the urban population), which represents more than 100% increase in city dwellers in a period of less than 20 years.(Bearing in mind that 25% of the dwellings have been built between 1999 and 2005 and for the other 75%, 2/3 of them necessitate whether a rehabilitation or some maintenances)*. The impact of this rapid urban development is that large areas of almost all the Algerian cities, situated in the North of the country, look the same. So do Algerian cities look Algerian and if they do what makes them look that way ? As a result, the city of today differs from its past in several respects : size and scale, street layout, land use patterns, architectural style and type of housing. Traditional urban form and building which would have provided information about regional and national identity have been largely replaced by forms characterizing the international and universal buildings and spaces. These changes have altered the city's form and have given rise to questions about the impact of these changes on the image of the city in terms of size and cultural values. So the concept of urban space becomes a determinant of the ability of planners, architects, engineers and administrators to provide an environment which is adequately structured to avoid chaos and to maintain an acceptable quality of life.

2.STRUCTURAL TRANSFORMATION OF THE CITY:

The objective of part one is literature review that builds up a concept of the city main structure properties particularly in the process of urban transformation based on the structuralism approach which defined a structure as a system of transformation. The proposed structural approach to urban transformation of the built environment in this research is coming from an awareness of the meaning and concepts of city structure, city center and city evolution, comparative studies on the ideas of the theory of structuralism, are presented. These cover descriptive, explanatory and analytical
discussions.

Structural transformation is the major property of the city structure. The main source of transformation in cities is its city main structure. The city main structure is responsible for growth, development and finally, transformation of a city. Its impacts on the evolutions of the whole city, on transformation of pattern and variety of land uses, the physical growth, and its impacts on urban environment sustainability are under consideration in this part.

2.1 Structuralism:

The significance of structuralism is to look into knowledge as an entity. The concept of structure is used in a variety of academic disciplines and cross-cultural contexts to question form, order, systems and transformation. Structuralism proposes in essence the reconstruction of what is already known. Piaget (1968) claims that there are two important differences between global structuralism and the deliberative, analytical structuralism of Levi-Strauss, where the former speaks of laws of composition. Durkheim's structuralism, for example, is merely global because he treats totality as a primary concept explanatory, as such, the social whole arises of itself from the union of components, and its emerges.

2.2 General concepts:

The views on the process of changes in a city and its main structure consisted of various interpretations. The general term mostly used is change. The hypothesis based on the major differentiations between the term change and transformation that become very clear in the modernization processes in the urban environment for Arab cities. The other terms are growth, evolution, and development. The meaning of these terms for urban concept is derived from its common meaning.

2.2.1 Change

The meaning of change covers various ranges, from change with physical manifest to changes in activities or even economic or social-cultural characteristics. City systems and their elements can change through cultural and educative process. It is this form of change that is significant. It can, of course, imply direction, as though it is a product of conscious thought (Larkham; 1999). Human settlements are continually changing (Lang; 1994). The physical interpretation is the most perceivable form of the changes. Kostof (1992) reaches the conclusion that in cities, only change endures, that all cities are caught in a balancing act between destruction and preservation. The scale of change either physical or functional varies from a single element, which is the building as an urban unit, to the scale of the global form of the city. The changes could be organic or planned. There is necessity for changes in cities, as Lang (1994) claims, for, inevitably, changes in the public realm create new opportunities and new problems resulting in the need for future changes. The cycle is endless.

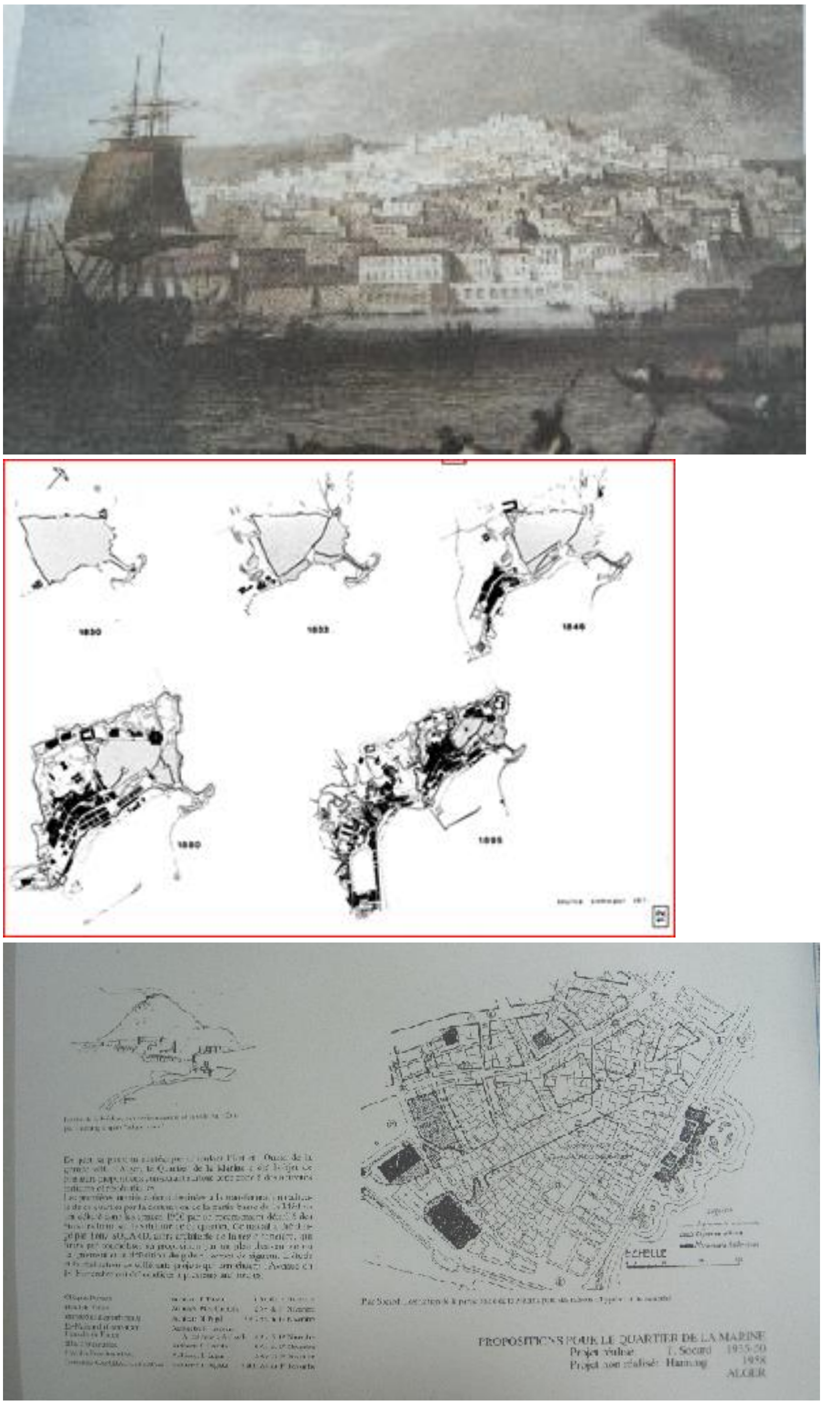

Figure 1. The Europeanisation of the traditional Islamic city of Algiers started by the French (1830-1962) in attempt to eradicate its Islamic identity.

2.2.2 Transformation:

Transformation is the most central characteristic of a structure. According to structuralism (Piaget, 1968), structure is a system of transformation, which generates and is guided by its inherent laws. The three key ideas of wholeness, self-regulation, and dynamism are tied together through the process of transformation in the structure. Transformation in a city occurs because of norms, semantics, and knowledge that are inherited in the social phenomena of that place. Transformation in a city structure is a result growing awareness of man and society. Transformation increases the complexity of system, always guiding it from simpler to a more complex system and structure. The continuity of the process of transformation relies upon patterns of surface structure, which is defined by the whole physical characteristics of the city.

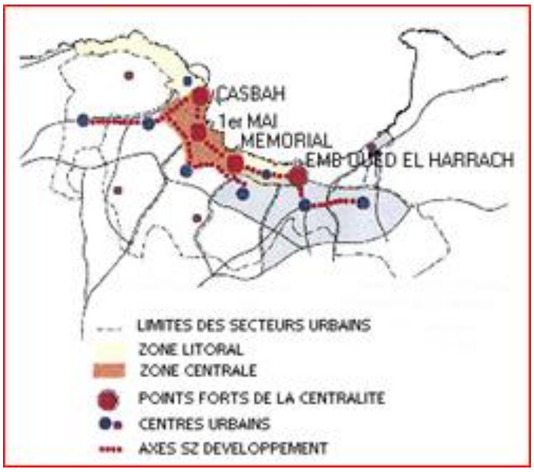

Figure 03. Political, economic and physical

Figure 04. Algiers transformation, an integrated developments combined to transform urban development with the old city the city of Algiers in 1985. Structure (GPU developed in 1990s).

2.3 The city structure:

The city structure is based on a whole entity; it is a global structure, which provides the relation among local structures of various areas. It gives both a sense of identity to, and a grasp of relations between the parts and the whole. Continuity is a physical property of the city if it is used to integrate the whole territory of the city. The city, as a spatial system, consists of a complex and bounded whole, encompassing a set of activities or constituent elements and the relationships among those elements, which together make up the system. The way a city can cope with all pressure, changes and express the self-regulation, depends to how city manage to transform, to increase and enrich the city as a system with clear distinction between change and transformation. In the simplest terms, change is imposed; it is not from within, whereas transformation uses the resources inherent within the structure to enrich itself and its identity.

Figure 05. Urban transformation mechanism for surface physical elements

2.4 Structural transformation:

Cities have to transform and they do constantly transform, but when the change are inconsistent and unconscious of the plurality of the existing city structure, they inflict damage on the principal rules which govern the city structure, in spite of any partial survival of the structure. Regarding changes in structure, Bourne (1982) states that a structure can become static, in which case it has to be broken in order to grow, or it can be dynamic, thereby, permitting growth without obsolescence. Structural transformation in a city clarifies the internal organism and mechanism of its growth and development through dynamic internal change. In this transformation all the relevant parts of the city interacts as a whole with its organization. The result of structure transformation is preservation and improvement the whole city structure global and local- properties and performance, also; the common result of structure transformation in city main structure is shifting the role of the traditional integration core in urban life. A city, however perfect its initial shape, is never complete, never at rest (S.Kostof, 1991).

CITY STRUCTURAL TRANSFORMATION: A SUSTAINABLE PROCESS FOR URBAN ENVIRONMENT MODERNIZATION

A structure is considered to be an abstract set of formal relations underlying the greater manifestation of observable forms. Eiseman distinguishes a surface or perceptual structure and a conceptual or deep structure. Deep structure is specified as an abstract underlying order of elements that makes possible the functioning of transformational rules. The surface structure is the transformation of a deep structure.

3.1 Underlying forces within the city structure:

According to structuralist paradigm, transformation within any kind of structure takes place because of underlying forces and mechanism of how these forces work together. For the city structure these forces could be interpreted as deep structural elements. Underlying forces are densest in the city main structure. All kinds of transformation like cultural transformation are more evident, powerful and more effective within the city main structure are the concentrated laws for cultural activities and monuments, attraction for people coming to these places and so places of greatest interaction between them. Consequently the city main structure is the place that the power of whole underlying forces emerges. The surface structural elements, like different places, buildings, and activities are the way the society responds to the forces embedded in the city main structure.

3.2 Principles of city structure sustainability:

"Sustainable architecture involves a combination of values: aesthetic, environmental, social, political, and moral. It's about using one's imagination and technical knowledge to engage in a central aspect of the practice -- designing and building in harmony with our environment. The smart architect thinks rationally about a combination of issues including sustainability, durability, longevity, appropriate materials, and sense of place. The challenge is finding the balance between environmental considerations and economic constraints. Consideration must be given to the needs of our communities and the socio-cultural paradigm that helps the urban transformation during the development and modernization process in the Arab cities. The following principals are the major aspect to achieve the sustainable city structure: • Understanding Place - Sustainable design begins with an intimate understanding of place. If we are sensitive to the nuances of place, we can inhabit without destroying it. • Connecting with Nature - Whether the design site is a building in the inner city or in a more natural setting, connecting with nature brings the designed environment back to life. • Understanding Environmental Impact - Sustainable design attempts to have an understanding of the environmental impact of the design by evaluating the site, the embodied energy and toxicity of the materials, and the energy efficiency of design, materials and construction techniques. • Embracing Co-creative Design Processes - Sustainable designers are finding it is important to listen to every voice. • Understanding People - Sustainable design must take into consideration the wide range of cultures, races, religions and habits of the people who are going to be using and inhabiting the built environment. This requires sensitivity and empathy on the needs of the people and the community.

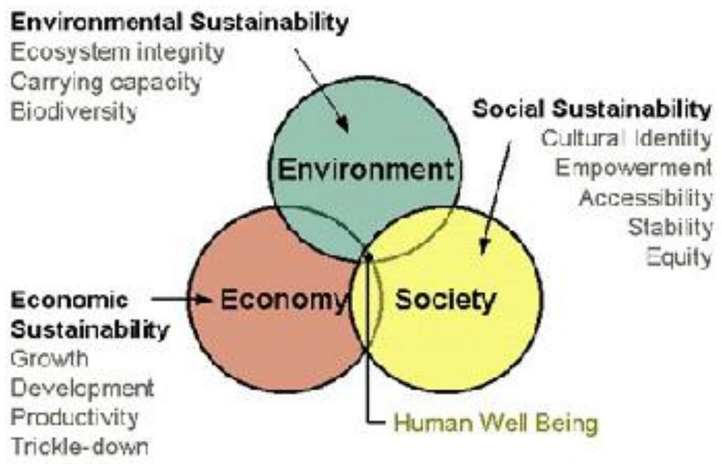

Figure 07. Three dimension for environmental sustainability . Source: http://www.arch.hku.hk/research/BEER/sustain.htm-**31/12/2005**

Social dimensions of Sustainability	**Environmental dimensions of sustainability**	**Economic dimensions of Sustainability**
• Reduced waste, effluent generation, emissions to environment efficiency	Inhabitants health and safety Impacts on local communities	Creation of new markets and opportunities for sales growth Cost reduction through
• Reduced impact on human Health inputs	quality of life; Benefits to disadvantaged groups	improvements and reduced energy and raw materials
• Use of renewable raw materials Elimination of toxic substances	e.g disabled	Creation of additional value.

3.3 Socio-cultural force as a deep structural element:

The underlying forces are the elements of the deep city main structure while the physical elements are the elements of the surface structure. Interaction between the forces is manifested on the surface characteristics. That interaction is based on laws of composition as city structure property. Transformation in the surface elements among the city structure leads to survive the responsiveness of the city. The central concern in any study of the city structure should refer to the interrelationships of the underlying forces. Physical environment determinants, social needs, demographic pressure, culture and religion, political issues and technological development, could be considered as some of these underlying shaping forces. The inherent power of sustainability and responsiveness, even after the worst periods of deterioration, can be considered as the self-regulation of the structural property and the process of transformation. This is dependent on the interacting mechanism of socio-cultural forces and on the balanced status between them.

3.3.1 Social forces:

The social force is a driving force. It embodies in human beings the desire to socialize and belong to a society. People are unconsciously aware of the social forces and accommodate them within the settlement structure and then interpret them onto the surface structure, to the spatial layout of the settlement structure. The need unconsciously embedded in the human soul to socialize, are fulfilled by formation of city structure. Social structure determines the social distribution of space and the evolution of urban spatial. Even the appearances and physical organizations of objects in public spaces depend on the social forces, because these kinds of spaces within the city main structure are supposed to be the containers for social life. Social relationships address the dynamism and transformation within urban environment and the social communication.

3.3.2 Cultural forces:

An important aspect of culture with considerable impacts on city structure, especially the city main structure, belongs to religion in its many interpretations across time. Religious should be considered intrinsic in human life. Religious beliefs are the context of culture and at time have had the highest degree of influence on human civilization, and consequently on major urban objects. It many instances religion was so predominant in the physical structure of the holy cities as to be the very essence of them.

3.4 Sustainable urban principles of the Arab city structure. A sociocultural view.

A number of factors played decisive roles in ordering and shaping the plan and form of Arab and Muslim city. In addition to the influence of surface structure factors, local topography and morphological features of pre-existing town, the Muslim city reflected the general socio-cultural, political, and economic structures of the newly created society. Saoud (2001) defined the concept of quality of urban environment in terms of both “sustainability”, and “city structure” quality, based upon the sociocultural paradigm; In general this involved the following: • Natural Laws: The first principle that defined much of the character of the Muslim city is the adaptation form and plan of the city to natural circumstances expressed through weather conditions and topography. • Religious and cultural beliefs: The religious beliefs and practices formed the center of cultural life for this population, thus giving the mosque the central position in spatial and institutional hierarchies. The cultural beliefs separating public and private lives regulated the spatial order between uses and areas. • Design principles stemmed from Sharia Law: The Arabic Islamic city also reflected the rules of Sharia (Islamic Law) in terms of physical and social relations between public and private realms, and between neighbors and social groups. • Social principles: The social organization of the urban society was based on social grouping sharing the same mentality, ethnic origin and cultural perspectives. Development and modernization were therefore directed towards meeting these social needs especially in terms of kinship solidarity, defense, social order and religious practices. Factors such as extended-family structures, privacy, sex separation and strong community interaction were clearly translated in the dense built form of the courtyard houses. The social organization of the urban society based on social grouping. Social and legal issues were taken over by religious scholars who lived in central places close to the city main structure which contains the mosque and the public life were disputes mostly arose.

4.URBAN GROWTH OF ALGIERS: FROM A TOWN TO THE METROPOLIS:

Just as many other cities do, Algiers comes from a small town on the coast, encircled in walls and surrounded by fields. Until late in the XIX Century, these walls were used as a separation between the urban center and the small villages and « summer residence » or Fahs.

Algiers :Repartition of houses, dwellings and villas in 2003. (Reference : Laboratoire de Geographie et d Amenagement Urbain, University of Science and Technology « Haouari Boumediene »)

	Block of flats and apartments	Villas and individual houses	Traditional houses	Ordinary dwellings	Temporary houses	None declared	Total
Units	1632682	148550	42839	4018	22744	3511	385344
Percentage	42.45%	38.55%	11.12%	1.04%	5.90%	0.9%	100%

Algiers in Arabic means a group of islands, during the Phoenician period, the land of Algiers was used as a trade post for the sake of commerce. In the Roman times, Algiers was called Icosium, was an unimportant city comparatively to Cherchel or Tipaza. In the tenth Century, Bologhine Ibnou Ziri founded a permanent settlement which developed into the Casbah and port of Algiers. After Algiers, during the Ottoman period and particularly with the Barbarous brothers (Aruj and Kheireddine) whom developed the maritime commerce by developing the port and the city was known as the headquarter of the most successful arm of the Ottoman fleet.

The Casbah of Algiers and the localization of the so called the « citadel » is an illustration of the basic condition of urbanism. The « citadel » (or a mini - city within a city) retain the symbolic centrality as it was the ruler's refuge and in the same time, it symbolized the administrative and military center. The space in the medina is a particular and specific conception that can be perceived as a positive actuality of volumetric form and the prerequisite medium from which the whole fabric of urbanism should emerge. This concept of space is prototypical and its essence is discernible in different spaces and situations of the Casbah.

Another criteria very important in the case of the Casbah of Algiers is the topography, this criteria not only shapes in some respect forms and spaces of the medina but determined also the localization of buildings such as the mosques, the palaces and the « citadel ».

During the French occupation, the extension of the city has grown up around the medina, there was a spatial separation between the ottoman and the French urban spaces excepted the center of power called « the marina district ». At the French occupation , the walls were pulled down after 1832, the fortress in the Casbah dismantled, and the strip of fields had been urbanized following the military project developed by “ le genie militaire” and whose works started by 1860, known nowadays as « Municipality of Algiers ». This area had been incorporated as part of Algiers with an important symbolic, social and artistic role, taking the part of a functional center the same as the old nucleus had always been.

Later, with the introduction of a new mode of transport (railway), those small centers in the surroundings (particularly the districts called :Mustapha Supérieur and El - Hamma) got integrated formally into the city by 1880 , these areas received at that time all the industrial activities (due to their proximity to the railway and the port). However, some of them remained as summer residences like the district of El - Biar, and others as subsidiary centers like Bir Mourad Rais or Bouzaréah.

In the beginning of the XX Century, a new style of architectural language was developed. From the architectural and cultural points of views, this style called the Arabisance referred to the traditional buildings.

From 1930 until the recovery of the independence, Algiers served as an experimental area for the development of ideas reflecting the vision the city as claimed by of the Modern Movement.

In the 1960's, Algiers was estimated for almost 500.000 inhabitants, and due the departure of the colons and the arrival of lots of immigrants, the city grew extremely, with speculation and without a general project concerning construction among the centers. Suburbs grew without any more identity than that of being built in the same physical space. As a result, the city of today is entirely and completely different from what it was in the past. The physical development can be characterized by its insensitivity to cultural values, and its ignorance of typological and morphological features. This development exposed Algiers to another problem which is the conservation of the traditional city. As masses of people had migrated from rural areas and from the mountains to the city; so in addition to creating squatter settlements on the outskirts of the city, the migration had and still is one of the reasons for the deterioration and destruction of the traditional city. The main aspects that can explain the deterioration of the medina are the densification and the judicial status of the houses.

In the 1970's, the decision makers of urban development focused on the distribution of functions by applying the Zoning, they tried to balance concentration of activities in the traditional city by a policy of decentralization and progressive endowment of peripheral dorm areas with qualified services both at neighborhood and urban scales.
The growth and extension of Algiers were oriented to the East side of the city, and many civil public buildings and housing were realized such as the U.S.T.H.B(University of Science and Technology « Houari Boumèdiene » at Bab - Ezzouar), thousands of dwellings were built particularly on the sites of Bab - Ezzouar, Bachdjarah and Bordj - El - Kiffane. At the end of that decade, the government realized that this development were done on the most fertile land from the agricultural point of view, so the decision was taken to reorient the development to the South - East. This orientation allowed the planners to suggest the delocalization of the industrial activities situated in El - Hamma and they proposed to increase the density of this district with high rise buildings developed principally as offices.
In the beginning of 1990's, the development was oriented on the basis of new laws in which the inhabitant should be involved as a participant. This development took into consideration what was launched in the 80's. The Master plan of the 1990's called the P.D.A.U.(Plan Directeur d'Aménagement et d'Urbanisme) was established on the following hypotheses :

The preservation of the traditional city or « la médina » ;

The densification of the districts El - Hamma and Hussein - Dey ;

The development of the main and important civil public buildings on the same virtual axis;

The objectives from these hypotheses were the development of a linear centre with a multi poles, and each pole should have a vocation. These poles are:

A historic pole represented by the Casbah reflecting the heritage of the Ottoman period;

The district of « Premier Mai, El - Hamma » were destined for tertiary activities, with the main buildings determining the notion of centrality in the city ;

The third pole « The memorial » was much more symbolic with political and cultural buildings;

The fourth and the last pole in the East side and opposite to the medina should contain the financial buildings, it represents the C.B.D.

In 1997, the city of Algiers was reorganized and it had a different status comparatively to the other cities of the country. Algiers was elevated as a gouvernorat and the limits of territory of this governorat are four times of what it was before when it was considered as a wilaya. The administrative authority had carried out a new structuring project called G.P.U. of the G.G.A.(Grand Projet Urbain du Gouvernorat du Grand Alger). The approach adopted in this project is based on the polarity of the city. Six poles were identified, so the territory is divided in six areas and each one had a vocation that should able the city to be competitive at the international level. Before the enumeration of these vocations, we must emphasize that this development focalized principally on the coastal areas. The six poles can be summarized as follow:

Pole one contains the medina and the first colonial center with the port: Cultural vocation;
Pole two composed of areas where their urbanization were done between 1880 and 1924, and during the French occupation, these areas were designated to industrial activities. The districts are: 1er Mai; El - Hamma and Ravin de la Femme Sauvage. The vocation of this pole is administrative activities;
The third pole nearby the second and presenting almost the same characteristics as the second except the slums which were developed along side « Oued El- Harrach and the industrial area of Oued Smar ». The pole contains the following districts : Caroubier, El - Harrach and Pins Maritimes, this pole should be developed for cultural and sportive activities ;The village created in 1860 juxtaposed to a group of buildings used, during the ottoman period, for military defense. This village was created for agricultural exploitation, and the development was oriented towards the agricultural activities and not to the sea. The districts of this pole are : Bordj -El - Kiffane ;Lido ; Verte Rive and Stamboul. The vocation was cultural and tourist activities.
The fifth and the sixth are situated at the West side of the medina, the others mentioned above are in East side. So these two pole composed respectively of Cap Caxine for the fifth and El - Djemila ; les dunes and Zeralda for the sixth which was designated for touristic and business activities. The main activities retained for the fifth were for tourism.

Algiers: The urban development of Algiers through the statistics. (Reference: Laboratory of geography and urban design,
University of Science and Technology « Haouari Boumediene », 2003)

	Population in 1966	Population in 1977	Population in 1987	Population in 1998
Designation	Grand Alger (according to the repartition of 1959 called Constantine's Plan)	Grand Alger (according to the new repartition of the national territory of 1974)	Grand Alger (according to the new repartition of the national territory of 1984)	Gouvernorat d Alger
Number of municipalities	10	13	28	57
Area	170km2	186km2	250km2	870km2
Population	1094851	1641521	2015374	2562428

We should say that for the last three poles that besides the lack of urbanistic structure - which obviously implies a lack of structure in the identity of the physical space, we must mention that most of these areas have developed during the post - colonial period and according to their potentialities, they present a poor development of the tertiary sector and almost no development of the services related to their status and localization from a regional point of view. Another aspect characterizing these poles is that most of the families living in the periphery are immigrants, they left their villages or lands for economical reason or they were searching for security. So they weren't interested in getting integrated and identified with their social environment.
This manner of structuring the city of Algiers was rejected, in 1999, by the president himself as it could lead to physical and social segregations. After the rain fall and the earth quake, the city council has been carrying a series of urbanistic interventions in the entire city: shaping of urban spaces, creation of some new ones trying to provide them with symbolic elements. The result is that any void was treated whether as a greenery space or an open space (I won't consider this open space as a plaza because the main reason for this space was emergency and not as a space for gathering or playing and without taking into consideration neither the climatic aspects nor the proportions between masses and voids).

5. ELEMENTS OF UNFRIENDLINESS: THE URBAN MORPHOLOGY BASE:

Several causes contribute to the inhospitality of the present urban environment. Most of them depend on the physical organization, the appearance of the city and therefore on the way it is planned and designed. Once again one set of problems rests on functional instances. The modern city envisioned as "machine a habiter", does not work properly; congestion of traffic, poor hygienic standards, and high pollution levels are some of the indicators of this phenomenon.

It can be assumed that the urban morphology can be approached through the analysis of certain specific character of the built environment. They deal with quantity of the distribution of built vs. inbuilt and private vs. public in the urban scenario, first of all in its two - dimensional organization on the ground plane. They include, also, the third dimension as the physical appearance of full vs. void, and further set of elements which deals with the dynamic aspect of the environment, i.e. with the activities that dwell in that environment, seen in their qualitative aspects, from the point of view of their appearance.

5.1Characteristics of the Medina:

The first and most characterizing elements of the traditional city is the organization of the urban fabric through the selection of built vs. inbuilt or in other terms, of volumes vs spaces. From a quantitative point of view, it relates to density and in particular to coverage, to distances and in general terms, to dimensions. It addresses the issue of a perceptual permeability. The most effective attribute of the urban environment is given by design of the boundaries between the realm of the empty space and the realm of the volume and by the syntaxes of the two entities. Related but non coincident with the figure ground is the block street pattern which highlights the articulation of the public domain versus the private. It deals with permeability, too, in physical if not perceptual terms.

The character of objects and non objects that we assume and anticipate for volumes and spaces in the two dimensional configuration, actually comes on stage with the third dimension. Height and shape of volumes concur with their layout to determine the physical quality of the urban environment. Bulk characterizes the volumes both in term of masses, height and profile, and of forms, skyline, setbacks, overhangs...etc. Bulk is further characterized in its spatial envelope by more specific architectural features such as colors, materials, patterns, textures, linguistic elements ...etc. Both bulk and architectural features contribute to determine the image of the city and its ability to carry hidden or direct messages of comfort, security, calm, dynamism, as well as recognition and orientation.

5.2Evolution of the urban morphology:

A quick overview of the basic and most recurrent character in the form of urban areas, classified by different origin (traditional or pre – colonial, colonial and post – colonial or contemporary), may help to identify the major relations between morphotypes of fabric and their performance in the general terms to quality of life.

1. in most cases figure ground and block street pattern almost coincide (with small blocks) or private spaces are internal (in larger blocks) and visually disconnected from the public network of streets;
2. Public spaces are immediately and continuously flab ked buildings and clearly defined;
3. Blocks are usually smaller;
4.The street pattern is highly structured and hierarchically organized (despite an apparently irrational organization of it): connector streets (both straight and meandering ones) link without discontinuities major parts of the city, piazzas sit along or slightly off them, distributor streets are smaller in length and width and often winding.

In the beginning, it has been underlined how the growth of the colonial city has destroyed or deeply spoiled the harmonic equilibrium of the traditional city.

In comparison with the traditional city, the expansion of the colonial city shows several new elements:

1. The street pattern appears more regular and geometrical;
2. Streets are wider and often enriched by tree lines, squares are wider and regularized.

Recurrent characters of the contemporary city layout are much more difficult to define. Pluralism of formal styles has found its analogous in different attitudes towards the organization of the physical environment. In the largest amount of cases, however, a few common characters can be selected:

1. Coverage density decreases, that is in the same quantity of land a smaller percentage of it is built on or, in other terms, the same quantity of built coverage is spread over a larger area;
2. Figure ground and block street tend to differ greatly: the organization of volumes is discontinuous; several built areas correspond to one large block;
3. In most cases the structure of the layout appears random, in other cases volumes are organized in a more or less geometric fashion;
4. Spaces are hardly ever designed either in a simple, recognizable or in a more complex way;
5. In many cases blocks assume leftover forms, derived from the disposition of the street pattern laid out after the circulation system needs.

The passage from the city of the recent past and the outskirts produced by our age is a radical shift. It reflects the character of an epistemological break: the conception of a volume oriented city vs. the tradition of the city organized by spaces. The traditional city keeps clear difference between residential buildings and institutional monuments, a formal consistency to a selected number of types in the former, a larger set of solutions for the latter. Heights of residential buildings are contained in a limited range. Street walls have rarely dramatic changes in height and being formed of different buildings (smaller in the traditional, larger in the contemporary city), they show a complex variety. Architectural features which derive from local style, construction process and materials give a formal unity to the whole and relate appearance of the physical environment to geographical areas. The typical contemporary city has no street walls. Its appearance is made of separated volumes under light as Le Corbusier had anticipated. Streets are formally undefined circulation tools. Proper piazzas do not exist being substituted by shapeless traffic intersections.

5.3 Irreproducibility of the traditional city:

The traditional city is more livable than the contemporary one because of the way spaces are organized, its volumes are put together and their surfaces are treated, and, in general, the way it was built. There is no room for nostalgia, however, the

traditional city is irreproducible, but not because of the stylistic intolerance of the modernistic attitude.
The situation we have to live with is made of more stable realities. The first one is almost obvious: the functional performance we ask of a city today is out of the reach of the pre - colonial city in terms of concentration, growth, circulation, activities...etc. The second one, less obvious but as relevant, we need to consider in any attempt to improve the built environment. It has to do with the changes in the production patterns which have been drastically modified without any analogous adaptation to the design and the control system.
Size and modalities of intervention by which the city grows have radically changed. Times of urban modification make the city dynamic jump in a different qualitative reality. Furthermore, from a construction industry point of view, the economic background has induced a rapid evolution of the market. The special nature of the product and its unusual life cycle seem to have represented restraint for the maturation of the market itself. Finally, from the point of view of public control, the tools that have been used so far, most of them informed to a limitative attitude, have proved to be inadequate to maximize the benefits of private and public investments on the public at large.

Between the end of the last century and the beginning of the present one, the ideal city started to look with progressively larger attention at images of the future as a reference for its organization. With the globalization, the architectural production is developed by what I consider the new stars or the new "elites" . Among the leading characters of what I consider as a reform, space, culture and history are directions towards which studies should headed? By doing so, we will recover values and positive characters of the traditional city while taking advantage of the technological progress. The architects and the common sensibility are rapidly evolving together with an increasing participation of the public to design process. Now that the collective consciousness is ready to back a new positive attitude towards designing and building the urban environment, the main themes rest on the tools and ways to achieve the expected results. Some of the tools that seem to have recently been the most effective from the public use and enjoyment point of view are related to the internal methodology of the discipline, the design process and before all, to the principles from which the designers's activity springs. Some others deal with the legal procedural frame tiding together the three main groups of actors in the urban development processes.

The building is composed of different elements which have different longevities. So :it is necessary to distinguish

Elements that do not need maintenance (foundations, pillars, beams, walls...etc.); Elements that necessitate a minimum of maintenance such as the interior paneling;

Because of the usury, some elements need to be renewed periodically (faucets, carpets...etc.);

Elements that have to be renewed due to mechanical factors (motors, fans, floodgates... etc.) or to the physical and chemical factors (asphalts, joints, painting... etc.);

Elements that have to be replaced while they continue to assume their function (sanitary devices, electric facilities... etc).

DISCUSSION:

It is clear that improving the maximum of the existing housing will not resolve the problem of habitat, the need for the construction of new lodging is inevitable. The new production contributes partially to this improvement, and we can say that the new lodgings will represent a yearly growth of about yearly growth of the order of 4% of the real estate park.

The rehabilitation and the modernization revalue the heritage. While either preserving or raising the habitability of the units to an acceptable level, we can in this case, maintain a balance between the demand and the new construction and the available resources to construct them. The nature of the heritage, the reality of our habitat make that the maintenance and the modernization should be treated as one of the activities of the construction. The improvement of the habitat requires that we have to maintain the existing and give it the same importance as the new constructions. This consideration will lead us to see: how can we make a judicious repartition of capital, labor and material between the rehabilitation, the new construction and the modernization. The rehabilitation and the renovation are more difficult to organize; they require qualified employees comparatively to the new construction. They include a lot of small and very various tasks or works, most of them are unforeseeable.

The main justifications for the increase of the expenses in the rehabilitation and modernization are:

1. The charges and taxes for the maintenance, the rehabilitation and the modernization;

2. The disproportion between the offer and the demand in terms of lodgings and population needs;

3. Acceleration of the change in all domains of life and which might explain the requirement for the frequent transformations;
4. The use of sophisticated facilities in the buildings increases the fragility of the latter and let them to be vulnerable.

From the technical point of view, the traditional city should be preserved by intervening periodically on its components whether in terms of maintenance, renovation or rehabilitation. In the central area, most of the traditional houses are built with a sustainable material. The accessibility to this area is easier and is already equipped comparatively to the periphery which needs infrastructure and consumption of land.

The problem of the qualification lead us to say that generally speaking, in for new construction, the qualified workers represents almost 20%, while in the rehabilitation or renovation this proportion is around 80%. The maintenance of the traditional buildings or their modernization necessitates an experienced staff as they should be able to recognize the weaknesses and to know how to remedy. So, this fact help us to understand why most of the employees are aged and don't work at the same cadence that their new construction colleagues, and of those whom are occupied in the new buildings, and generally speaking they are employed by a small and specialized enterprises. These enterprises are usually incapable to guarantee some social advantages offered by the famous or international enterprises and interested by the development and the construction of the new buildings. So the impact of this situation is the difficulties of recruitment in the renovation or rehabilitation. These aspects justify however the prices practiced by the enterprises and unaffordable by most of the population. It is known that the sector of construction and building is a sector that requires less qualified employees and for more than a decade, this rehabilitation and renovation were considered as secondary activities in this sector and from the cultural and heritage points of views, the main obstacle was and is the nature of property from the juridical side. So do we have to think about changing our strategy when it will be too late for preserving our heritage?

Rehabilitation and renovation are costly comparatively to the new construction, but these expenses become more and more important with the time. For a new building, they are around 0, 25% of its value per year, but they climb quickly to reach 1, 6% at the end of 3 years and 1, 8% of the forth year. Several things can be deducted of it: few saving gained while trimming on the quality of the construction which will have a great impact on the expanse for the maintenance. More the real estate heritage is old; more the charges for the maintenance are high. The exploitation of the renovated building is more expensive than a new one, because the value brought by the improvement of the arrangement and the equipment will not stop the process of usury and do not reduce the expenses. So in terms of sustainable development, the improvement of the habitat might be a poisoned gift for the future generations if we keep things as they are particularly in terms of qualification of the employees, the cost and the use as most of the renovated and rehabilitated buildings are used as museums, restaurants or for prestigious ceremonies: it is much more seen as an elitist attitude toward the preservation of our heritage.

CONCLUSIONS AND RECOMMENDATIONS

In structuralism theory, the structure is a system of transformation based on the evolution of the surface structure. The transformation of structure depends on the dynamic interrelations between the structure's elements. In structuralist thought, structure and transformation are bonded together and their interrelationship is reflected in the surface appearances of phenomena. The structure, then, can be understood by investigating its evolutionary process, which has transformed their entity while keeping identity. Arab cities change dramatically (Case of the G.C.C) or gradually (Maghreb : Algiers, Tunis, Rabat), assuming many different kinds of change. Physical growth, socio-economic development and urban evolution are all varieties of such change, each with its own meaning and variously based on different factors either physical or non-physical. Many factors like system information, economy, and technology play role in the changes. If a city relies on indigenous knowledge, technology, cultural values and tradition, these changes could be considered as transformation for all the energies that drive them emerge from within the city and its society, i.e. from its own structure. Many things can happen in a city that is changes not transformation. These are caused by process that are not inherent in the city structure and will weaken it. The Muslim city, with its socio-cultural features, had a cultural, social, political, and economic logic in terms of physical fabric, layout, and uses, which can provide a lesson for modern planning and design practices. The modern Muslim city should maintain the deep structure identity, and then it can achieve the proper transformation of the surface structure without losing the unique features for its urban environment during the modernization process. As well; the Muslim city can be easily adapted to meet modern functionality and urban responsiveness and maintain its high congruence with our deep structure (our natural, religious and socio-cultural environment). paradigm of planning in the madina inorder to expose its intrinsic urban order that is not merely orthogonal or geometrical. This is argued by revisiting the concept of planning as an intention and action, in its historic context, while being prudent so as to not create confusion with the current urban planning, the objectives and tools of which are totally different. However, the lessons gained from inquiring into madina's urban mechanisms, and their sustainable synergies, may support the current planners to bridge the gaps in the making of current chaotic cities – which are void of sound communal constructs and rely heavily on aesthetic orders. Before embarking on presenting the planning paradigm of the madina, a brief review of its persistent Orientalist images was essential in order to expose their deliberate emphasis on its unplanned nature. While intentionally disregarding the apparent social and cultural order of the madina, which manifested a typical sustainable urban pattern throughout its history, these images were driven by using widely external aesthetic and form typologies.

To prove the attitudes of planning in the madina, a review of different actions of organizing or making order was necessary so as to reveal its comprehensive urbanism, and distance it from the colonial notion of a confined me´dina. This has led to the discussion on its different levels of planning and what constitutes its urban parts following the jurisprudential and functional archetypes.

While the madina is presented as not a merely totalitarian and authoritative territory, its consistent social and spatial microcosmical order through its strategic corpus' internal and neighbourhoods' local planning is explored.

The notion of order behind its compact urban fabric is also substantiated through different meanings that stem from a user's experience in a beehive urban fabric. However, the modern planning practices have come to vindicate the relevance of such a beehive urban structure that places the human being at the centre of an urban space, which creates a sense of belonging and memory in a city that several current living madina(s) have proved.

The main strength of the current madina is its sustainability as a city capable of encountering the challenges of twentieth-century urbanism, particularly in developing countries. This paper argues that the historic urban experience and deduced lessons of planning from historic cities could open a new horizon for contemporary planners to assimilate the complexity of human space without being biased to a certain orthogonal order that is merely aesthetically geometrical or culturally superior.

REFERENCE

Boudiaf, B, 2006: Homes, Dwellings and the Quality of the Urban Spaces: case of Algiers in the 5th Symposium on Architecture and Development, Ajman University of Science and Technology, Faculty of engineering, Department of Architecture and interior design, Ajman, U.A.E., 22nd March 2006;

Boudiaf, B, 2007: The future of our past in 2nd International Conference and Exhibition on Architectural Conservation: Opportunities and Challenges in the 21st Century, Dubai Municipality, U.A.E., 11th-13th February 2007.

Boudiaf, B, 2011 : Algiers: Place, Space-Form and Identity: Martyrs' Plaza as a case study, in City Identity in the 21st Century: Challenges and Opportunities, 5th Ajman Urban Planning Conference 21st-25th March 2011, AJMAN,U.A.E.

Boudiaf, B & Mushatat, S, 2012: Towards a responsive environment, Lambert Academic Publishing, Saarbrücken, Germany.

EL-Kadi, H, 1999: On Cultural Diversity and Technology. In Architectural Knowledge and Cultural Diversity. William O'Reilly, ed. Lausanne: Comportements.

Fawcett, J. (Ed). (2001): The Future of the Past, Whitney Library of Design. NY

Hakim, B, (1986): Arabic Islamic Cities; Building and Planning Principles. Routledge, Oxford

Michelle, G. (ed.), et al (1978): Architecture of the Islamic World. London, Thames and Hudson.

Rantsis, S., 2004. Community Participation and Impact of Conflict on the Conservation of Traditional Architecture. In: The 1st International Conference on Heritage, Globalization and the Built Environment, 6-8 December, Manama: The Bahrain Society of Engineers, 151-166.

Rapoport, A., (ed.) 1976:The mutual interaction of people, and their built environment: a cross- cultural, Perspective, Chicago: Mouton

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The Architecture and Beyond of Tread and Riser

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Abstract

The primary constitution of stairs is the arrangement of horizontal and vertical measures known as tread and riser. This is the simplest arrangement that essentially conveys people from one level to the other with required comfort and safety. Steps are a universal symbol with multiple interpretations. They are the most generally used similes in art, philosophy and psychology. Stairs occupy a unique status in the built environment because they not only convey people, but also symbolize the psychological, spiritual and artistic aspects of human nature. The mental significance and symbolic connotations of steps are deeply rooted. Understanding the role of stairs in different spheres of human need and expression is crucial in approaching its design. The pattern of stairs is dependent on the type of materials and other related design considerations. It is one of the

Keywords:
Analogy, Pattern, Perception, Riser, Tread

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unique architectural entities that reflect the various facets of social, psychological, artistic, metaphysical and religious dimensions. The importance of physical activity in the rising sedentary life styles is linked to the design of building elements, especially the staircases. The advancement in technology has displaced the role of stairs into an inconsequential means of emergency escape. But the importance of physical activity in the rising sedentary lifestyle has revitalized the concept of stairs as an active building component. The mono functional approach to staircases in high-rise buildings, especially as the means of escape in emergency situations, indicates that the design of staircases as multi functional element is still under the confines of design explorations. This paper is an attempt to understand the concept of stairs not only from the evolutionary point of view, but also the associated metaphoric meanings and its emerging multi facet identity. The concept of vertical accessibility in the form of tread and riser arrangement makes stairs a timeless phenomenon. The approach to multi utility architectural elements stretches beyond physical functions and should integrate the various dimensions of space making and society. In this regard stairs are a pioneering entity that has a potential to relate to many spheres of human thinking. It is clearly evident that stairs are not bound within the confines of architecture. Their origin, utility and design have far more influential qualities that travel beyond the realms of function and symbolism. It is further discussed that in the present age stairs have become as an inspiration for physical well being. The issues involved with age based capabilities demand a certain design approach that satisfies the sensitive relation between built environments and building elements.

INTRODUCTION

The primary constitution of stairs is the arrangement of horizontal and vertical measures known as tread and riser. These are the basic elements that are responsible in creating the rich cultural and technical facets of staircase architecture (Alan & Blanc 2001). The stairs are one of the primitive elements in architectural history. Every civilization has used some version of stairs or ladders to reach higher elevations. Even in the present era of high rise architecture the role of stairs is irrefutable (Berger, Theuring & Adolph 2007). The different design aspects of staircases can be traced through thousands of years of human history. A settlement called Catal Huyuk during 7000 BC in Asia Minor region of Turkey had houses connected to each other with no doorways (Mellaart 1962; Steadman 2000). The access was from a hole in the roof by means of a movable ladder (Mellaart 1962). This settlement is clear evidence that man had the device and ease of moving vertically from prehistoric times.

Steps have always been an essential part of a shelter. To be a few feet above the ground creates safety and protection. This occurred naturally as the action of climbing trees translated into the aspect of protection against wild animals and escape from the water logging in rainy seasons (Alan & Blanc 2001).

Arranging blocks of stone that form accessible horizontal and vertical surfaces leading to changes in levels has been a method from primitive days. As civilizations progressed, places of congregation were built high up on a mountain or high structure was erected followed by a series of steps. The set of steps that connect two different levels is termed as a staircase or stairway. According to Campbell and Tutton (eds 2014) a short staircase is a part of the extensive remains of the prehistoric Tarxien Temple and Saflieni Hypogeum site in Malta, that date back to 3600 - 2500 BC. These are probably the earliest free standing megalithic monuments in the world. They state that almost every significant building from the ziggurats of ancient Mesopotamia to the present day has accentuated the identity of stairs. Staircases are compelling and enigmatic because they not only invite ascent or descent, but also create subtle excitement to see what unfolds above or below (eds Campbell & Tutton 2014).

Figure 1.
Pyramid of the Magician, Uxmal. Templer, John. *The Staircase.* Cambridge, Mass., London, The MIT Press, 1994. *(Pallasmaa 2000, p.11)*

Apart from the basic function of conveying people to different levels, stairs inspire different analogies in artistic, psychoanalytic and philosophical interpretations (eds Campbell & Tutton 2014). Staircases are an example of the interaction between building design, the surrounding environment and users (Zimring et al. 2005). Staircases are an important feature that influences user behavior, both physically and visually. It is not only the tread and riser that constitutes the staircase, but the supporting elements such as the rail, the material of the staircase, and landings, that augment the conveyance of people in a safe and comfortable manner. This process has reinvented itself from primitive times to the present era of skyscrapers, multi planar artistic endeavors and life style awareness activities. This paper is an attempt to understand the concept of stairs not only from the evolutionary point of view, but also the associated metaphoric meanings and its emerging multi facet identity.

Figure 2.
A Jacob's ladder in landscape terms: steps called 'the sky ladder' at Tai Shan, China (551 BC) (from Schuster, F., Treppen. Hoffman Verlag, 1949) *(Alan & Blanc 2001, p. 5)*

PATTERNS OF TREAD AND RİSER

There is no limitation to the pattern of arranging treads, risers and the additional features that provide safe access to the different floors of a building. Risers divide the total vertical climb into small increments that the legs can negotiate comfortably and treads provide uniform level and secure footholds (Allen 2005). Hawker describes that a step is both the action of vertical foot movement as well as horizontal foot rest that supports the movement from one level to another (Erickstad 2012). The wide array of tread and riser patterns reflects the relation between staircase design approach and the building typology.

Type, Purpose and History

The history of the staircase is not linear. Different types of stairs are designed, the majority of which are innovated and reinvented (eds Campbell & Tutton 2014). According to Miles (1999) the function of a staircase must be deduced from its physical remains. He states that the formal pairs of stone staircases are a characteristic of western Greek temples. The foundations in them emphasize that the interior stairs were an integral part right from the temples inception (Miles 1999).

There are different ways of arranging the steps in a staircase. Based on the type of material and the kind of purpose to whom it is catering to, type of staircase is designed. The geometrical arrangement of treads and risers in various patterns defines the names of different types of staircases. Direct flight, dog legged, open well, helical, imperial, double stairs are some of the general patterns of stairs. In many instances design of a staircase has been often the combination of these typical patterns and gets distinguished based on the materials and the type of structural system adopted.

According to Campbell and Tutton (eds 2014) the cantilevered stairs were invented by the ancient Greeks and reinvented by Andrea Palladio in Convento Della Cartia, Venice in 1561. They state that islands of Naxos and Andros in the Cyclades have two remarkable cantilevered staircases, both from the Hellenistic period, 500-300 BC. These staircases still survive in their circular towers that stand without visible support of the internal open well. The texts from Palladio's *the four books of Architecture* have been influential in the creation of dramatic structures of the turret and emphasize the advantages of open well stairs with stone cantilevers (eds Campbell & Tutton 2014). The direct flights of stair are the most popular in ceremonial approach and are often the most delightful because of the alignment of line of movement and line of visibility from one level to the other levels (Alan & Blanc 2001). It is the Renaissance and Baroque styles that recreated many of the grand straight flight stairs as an epitome to royalty (eds Campbell & Tutton 2014). During that time, many original and majestic forms of staircases can be observed. In I570, Palladio exhibited his staircase designs as *inventions* and the Renaissance was the period of innovation for the staircase forms like a spiral, converging flight and double-helix (Wilkinson 1975; Good 2009). Further the straight flight design was developed into open well stair and the Imperial stair.

Among the early civilizations, the Romans were pioneers in staircase design and construction. This is evident from the fact that the sheer scale of Roman buildings demanded a complex system of stairs. There is an overwhelming evidence for domestic stairs, especially in dog-legged form in residential and commercial structures of the Roman times (eds Campbell & Tutton 2014). Templer states that the grand formal stairs of the Renaissance and Baroque palaces were generally dogleg (Erickstad 2012). The palaces and public buildings were extensively composed of monumental dog-legged staircase during the Renaissance in Venice. Apart from this, a conventional dog-legged courtyard staircase was a highly adorned processional component in both Romanesque and Gothic palace architecture. It was designed to express the grandeur that articulated the social hierarchy (Good 2009).

Straight flights, spiral forms and multi turn stairs are the general patterns found in many fortifications, castles and religious buildings. According to Alan and Blanc (2001) three turn stairs were predominantly used during Roman times and their presence in the remains at Ostia reveal multi storied tenement structures that once raised five storey's. The defense was an important aspect in the design of multi turn stairs, apart from saving in space. Approach stairs in citadels like Alhambra are strategically planned for right handed swordsmen fighting in defense. The attackers unless left handed were at a disadvantage at every landing (Alan & Blanc 2001). Neil states that even though defense was a major consideration, 'the idea of the clockwise spiral stair was designed to aid a defensive force is a popular myth' (as cited in eds Campbell & Tutton 2014, p. 37).

According to Good (2009) Leonardo da Vinci formulated the concept of double staircases. They had become a part of multi-family residential structures during the Renaissance. Two flights of steps are positioned in a criss-cross manner that creates separate routes for the courtiers and service providers, avoiding visual conflicts and maintaining least possible travel distances. He states that double staircase was originally devised as a part of military architecture to minimize the chance for treachery and conspiracy among the soldiers heading to battlefield (Good 2009).

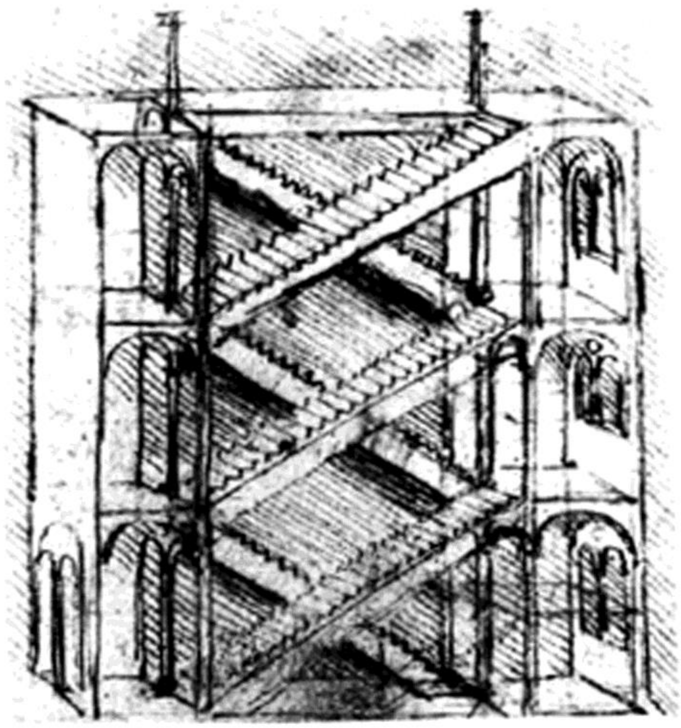

Figure 3.
Leonardo da Vinci's sketch for a double staircase *(Good 2009, p. 81)*

Helical staircases were common in the middle ages and since then many compositions have evolved such as the double helix and composite sculptural designs (Erickstad 2012). A classic example of a double spiral staircase is in the palace of Chambord de chateau, supposed to be designed or influenced by Leonardo DA Vince ideas (Tanaka 1992). This staircase enables the royal path to be separate from the rest, but at the same time with openness of the balustrades establishes the visual connections (Alan & Blanc 2001; eds Campbell & Tutton 2014). The grace of helical theme can be further understood in two examples. First, the famous exit ramp of the Vatican museum in Italy, designed by architect Giuseppe Momo in the 1932. In this, the diameter of the stairwell reduces as one descends, creating a dramatic effect of vertical splendor. Second the spiral gallery at the Guggenheim Museum in New York designed by Frank Lloyd Wright in 1956. The long curving ramp is perhaps the most celebrated pattern in the modern architectural history that not only emphasizes form but also the material (Alan & Blanc 2001).

Figure 4.
Exit stairs, Vatican Museum *(Alan & Blanc 2001, p. 25)*

Figure 5.
Gallery spiral, Guggenheim Museum, New York, 1956 (Frank Lloyd Wright): view downwards *(Alan & Blanc 2001, p. 25)*

Wilkinson (1975) states that monumental interior staircases find their origin from the late medieval period, during which imperial stairs were the most celebrated form. First constructed in Escorial, Spain, Imperial stair starts with one straight arm, and then after the landing, turning by 180 degrees and leading up to the upper floor with two arms to the left and right (Wilkinson 1975). This stair composition is developed upon a particular perspective view, which was a predominant quality of Renaissance (eds Campbell & Tutton 2014; Wilkinson 1975).

In understanding the different patterns of stairs, it becomes imperative to consider the term *step well*. It directly indicates the function and utility of this peculiar kind of well monument found in some parts of India. Both words of the term step and well characterize its inherent features. Juneja (2001) states that step well is the most intricate and complicated structure from design and construction point of view. It consists of three major architectural parts, namely, the vertical well, the stepped corridor leading down to the water and intermediate tower like pavilions which are open halls. All these combine to form a utilitarian and social function that not only satisfy the thirst, but also act as a place of gathering or resting, during summer seasons Juneja (2001).

The advancement in building materials is an important component in the evolution of the pattern of staircases. The arrival of wrought iron and later steel and reinforced concrete allowed design of stairs to be independent of their adjoining walls. They were used in creating more dramatic effect that exposed their inherent exquisite structural simplicities (eds Campbell & Tutton 2014). The use of concrete, steel and lately glass as staircase material has given rise to old patterns of stairs in new forms of visual delights. Alan and Blanc (2001) note that an all time example of the architecture of tread and riser for building material point of view is the design of ramps and stairs by Le Corbusier. Using these elements he transformed spaces into sculpted volumes that interpenetrated the floor spaces and became the hallmark of the Corbusian ideal (Alan & Blanc 2001).

Figure 6.
Villa Savoye, 1929-31, Architects: Le Corbusier and Pierre Jeaneret. Stair and ramp *(Alan & Blanc 2001, p. 57)*

Aspects of Comfort and Safety

Designing for vertical movement of people in and around buildings requires extreme attention to anthropometrics (Allen 2005). Walking on flat ground is easier than accessing a staircase. Climbing stairs means moving the body against gravity, that requires high energy and descending stairs means balancing the body weight and controlling the forward movement (Berger, Theuring & Adolph 2007). The drawbacks of the staircase are that they are not universally accessible and become fatigued after negotiating few steps (Allen 2005). A fall on a stairs is a potential risk that is inherent of any staircase. Stair climbing is always problematic for the elderly because of their weakening strength and stability (Berger, Theuring & Adolph 2007).

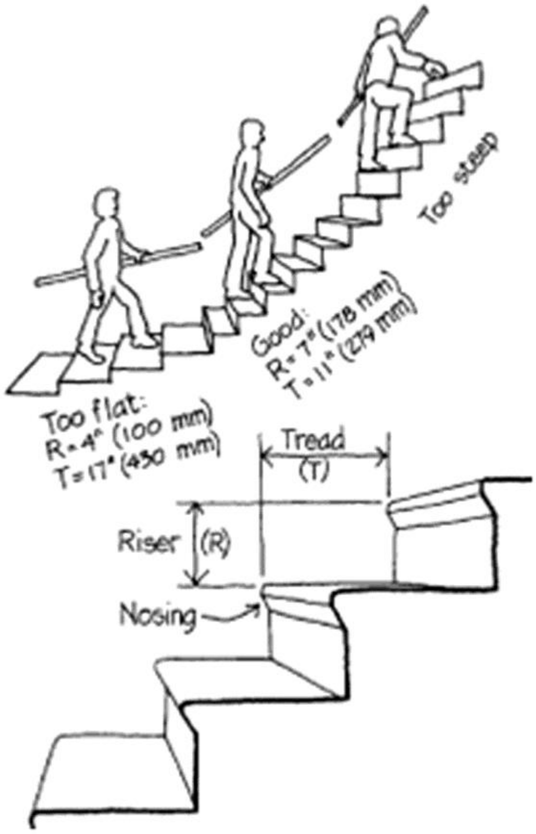

Figure 7.
Three types of tread and riser proportions *(Allen 2005, p. 165)*

Comfort and Safety are the two critical considerations in a staircase design. The question of safety deals with minimizing the chance of falling and when the fall happens, minimizing the seriousness of the injury. Campbell and Tutton (eds 2014) observed that the descent of stairs is associated with more falls than the ascent. They state that the appropriate measurements of the stair have been the concern of architectural theorists since Vitruvius of Rome to the Renaissance theorists like Leon Battista, Alberti and Andrea Palladio. According to them, the earliest recommendations for tread and riser proportions are from Vitruvius. He suggests that stairs should follow the proportions of Pythagoras triangle, with three being the riser, four the tread and a pitch of 37 degrees. Further, in 1698, the first mathematical relationship between the riser and tread is found in Blondel (2R + G = 0.6 m), followed by Violet Le Duc's pitch of 22 degrees in 1840 and the Newlands equation of R x G = 1.67 m in 1865. In 2000 as per BS 5395, 2R + G should be in the range of 0.55m to 0.7m (eds Campbell & Tutton 2014, pp. 254-255]. The rule of thumb in today's architectural practice is riser plus tread should be equal to 0.63m. Even this present practical rule of thumb only guarantees a certain average physical comfort (Pallasmaa 2000).

Stairs have the potential to be as deadly as their use (eds Campbell & Tutton 2014). Templar states that 'a lack of a system of design principles has obliged designers to make assumptions or to guess at what constitutes a stair that is safe, comfortable, and convenient' (Erickstad 2012, p. 55). The number of risers in a flight plays an important role in the safety and comfort of using the stairs. According to Allen (2005) flights less than three risers often escape the notice and can lead to a fall, whereas flights more than 16 or 18 risers cause fatigue. Long flights are needed to be broken with periodic *landings* whose minimum dimensions should be equal to the width of the stair (Allen 2005). The need for landing has been considered since the Renaissance. Alberti mentions, having an unbroken flight of more than seven or nine steps requires landing, which acts as a place to check or contain the fall. Even Palladio considered this aspect as a crucial element in staircase design (eds Campbell & Tutton 2014).

According to Scott (2005) staircase is the most serious accident prone area that individuals encounter in the building environment. He states that the highest chance of a fall occurring on the stairs is during the swing phase and weak slip resistance of the tread has the maximum potential to cause tripping (Scott 2005). Templar (cited in eds Campbell & Tutton 2014) study found that a majority of accidents happen on top three steps or bottom three steps. He states that 'There is no direct correlation between the number of steps and occurrence of accidents' and that the design of the staircase, distractions and the poor maintenance of the steps are the major causes of stair falls (cited in eds Campbell & Tutton 2014, p. 250).

Jackson and Cohen 'concluded from an in-depth analysis of 40 stairway accidents that the greatest problem with accident stairways was not individual (user) or external variables, but dimensional inconsistency inherent in some stairways' (cited in Scott 2005, p. 11). The vulnerability of falling and the effort of using stairs must be minimized by the comfortable accommodation of bodily movement (Allen 2005). Handrails and guardrails must be designed and positioned in such a form and location that they should be easily grasped in an event of potential fall. The issues regarding the tread and riser relationship, handrails, lighting, slip resistance, irregularity of design, and user behavior, such as running and carrying items are crucial factors in designing a safe and comfortable staircase.

ANALOGY OF ASCENT AND DESCENT

Understanding the metaphoric meaning of a stair is as important as analyzing its practical function and evolution. Pallasmaa (2000) emphasizes that throughout the timeline of architectural history, stairs has represented various social and spiritual ideas like power, prestige, abode of gods and way to higher planes of consciousness. He states that climbing steps symbolizes a conventional longing of the human psyche to reach the higher spheres of universe (Pallasmaa 2000). It is interesting to note that the majority of the temples of ancient civilizations is often terraced in the form of steps, but at a gigantic scale. According to Bollas (2000) some anthropologists believe that ziggurats were created as memory of mountains which were left behind by the Sumerians, who migrated from a more mountainous region or perhaps they created them as an expression of devotion that resembles the might of nature (Bollas 2000).

Symbolic connotations associated with stairs are represented in, ancient Egyptian and Mexican pyramids, Greek temples, Biblical depictions, Buddhist shrines, Renaissance palaces, and many other belief systems and cultures. The creation of an elevated structure indicates the social or spiritual status. This principle is still applied in geographical positioning the buildings and structures of importance. It is the architecture of a staircase that is pivotal in creating an influence and impact on people and the society at large. The Greek's experience of architecture is believed to have primarily influenced their philosophical thought. Their analogy with a building paved way for the idea of knowledge and the structural properties of their language (Onians 1992). Miles (1999) observes that, during the Roman Empire, especially in the temples of Syria, Lebanon, and the east side of the Jordan River, stairs for ritual ceremonies were a prevalent architectural feature. In the Mediterranean world the sacred buildings exemplified the experience of ascent as a symbol of achieving proximity to the divine (Miles 1999).

According to Onians (1992) the political career during Roman time, was regularly thought in terms of the ascent of a staircase of honors. He states that the Romans developed the linguistic expressions such as Podium, the tribunal and rostrum which reflected the social authority and hierarchy, whereas the word podium, which is Greek in origin, does not in that language carry any allusion of associated status. In Greece, statues often stood either singly on a simple slab at ground level or collectively on a larger base; Romans raised statues on individual pedestals whose relative height indicated the importance of the person commemorated (Onians 1992).

Heaven and Hell are considered as one of the strongest connotations of the staircase throughout history (Erickstad 2012). Rising stairs end in Heaven, whereas descending stairs eventually lead down to the underworld is a popular notion among different belief systems (Pallasmaa 2000). Irrespective of any faith, spaces of worship are constructed in higher elevations symbolizing the way to heaven by climbing steps. Alan and Blanc (2001) describe a differing connotation with steps that lead into sunken chambers or that disappears under water. They state that the psychology of descent below ground water is diametrically opposite to the optimism in climbing. The cistern temples in India are among the significant examples where the descent indicates the ceremonial cleansing at the lowest level (Alan & Blanc 2001). Slessor explains that the steps on the banks of the Ganges River in India represent Hindu rituals of life and death (Erickstad 2012). The theme of descent and purification is an analogy to express the descent required for penance that eventually leads to ascending the higher levels of consciousness.

Figure 8.
Water steps and tank, Temple at Chidambaram, India (courtesy of Timothy Blanc) *(Alan & Blanc 2001, p. 71)*

The steps are very common as a symbol in iconography. The Dictionary of Symbols by Biedermann states that 'steps and stairways represent the ascent to a higher plane' (cited in Erickstad 2012, p. 19). From the inner life point of view, accession to a higher level indicates the 'upward impulse' that is not relative to any actual ascent (Cirlot 1971, p. 20). Mircea Eliade states that 'ascensions of all kinds, such as climbing mountains or stairs or soaring upwards through the air, always signify that the human condition is being transcended and that higher cosmic levels are being attained' (cited in Cirlot 1971, p. 20). Usually stairs represent the essential ideas such as ascension, gradation, and communication between different vertical levels. The actual number of steps involved carries a prominent symbolic significance (Cirlot 1971). In medieval churches, three steps leading to the altar symbolize faith, love, and hope (Erickstad 2012). According to Humphrey and Vitebsky (2003) Baroque architects of the 18th Century built 'sacred stairways' so that the approach to a church was itself instilled with spiritual reverence. They further state that the best known analogy of steps in a church is the Rome's church of Santa Trinita approached through three flights and three landings representing the trinity (Humphrey & Vitebsky 2003). The famous eighteen steps of the Sabarimala temple in India is also an example of the metaphysical significance associated with the number of stairs. In Freemasonry, the degrees of initiation are represented through the steps.

Three steps correspond to moderation, justice, and benevolence. Seven steps represent the seven liberal arts of the medieval world, the seven ages of man, and the seven cardinal virtues, believed to lead to self-knowledge, mastery and improvement (Pallasmaa 2000, pp. 10-11).

Onians (1992) suggests that architectural metaphors are present very much in the day to day communications. He states that they uniquely satisfy humans mentally because they recall the way architecture satisfies physically. Stairs carry more associated symbolic undertones due to the fact that they are indirectly used in representing many developmental stages. One such example is the symbolic connotation associated with a regularly used term 'wage scales' that is derived from Latin *scala*, meaning ladder or stair (Onians 1992, p. 206). According to Sigmund Freud 'the regular rhythm of stairs also addresses our dream imagery through its essence as a sexual metaphor' and the image of stairs in a dream symbolized repressed sexual desires (Pallasmaa 2000, p. 10). Carl Jung, the founder of analytical psychology observes that,

The depiction of steps and ladders in dream symbolism portrays the process of psychic transformation with up and down movements. Our psychic prehistory is in truth the spirit of gravity, which needs steps and ladders because, unlike the disembodied airy intellect, it cannot fly at will (Erickstad 2012, p. 65).

The French philosopher Gaston Bachelard states that, 'the stair mediates between the different metaphysical realms of the house of our dreams' (Pallasmaa 2000, p. 9). He further theorizes

'the psychology of the house in terms of verticality and the dialects of up and down. This is explained by the descriptions of the Attic and Cellar as inhabiting areas of the mind, both accessed by staircases…We move down to the basement and ascend to the attic, creating references to our real and imaginary lives' (Erickstad 2012, p. 72).

Another important arena that holds the analogy of stairs is movies. Staircases are used to depict many themes in cinema. It is the general observation that climbing stairs implies withdrawal into privacy and descending signifies entry into the social sphere. They are used frequently in movies not only as a motif, but also as a crucial feature that renders the particular genre. The staircase is probably one of the unique architectural elements that not only connect levels, but also relate to the different physical, social and metaphysical expressions.

SIGNIFICANCE OF STAIRS IN THE PRESENT TIMES

Even in this era of digitalization and skyscrapers, the relevance of stairs has not diminished, but getting enhanced. The shift in the attention of staircase from a grand central element to the cornered and subdued element as an emergency escape is again reinventing itself as the agent of physical well being. This is because of the rising sedentary life styles which is one of the outcomes of technological advancements. Since most of the people tend to spend the majority of their day in buildings and its immediate surroundings, the connection between physical activity and building elements becomes very obvious. In this regard, there can be no denial that the physical environment plays an important role in affecting the health of an individual. Zimring et al. (2005) states physical environmental factors in four different scales, starting from urban design, site selection and design, building design, and building element design. They emphasize that the design strategies at the building level, such as motivational point of decision prompts, aesthetically pleasing staircases, and accessible physical activity facilities are assuming a new level of significance from the design perspective (Zimring et al. 2005).

Considering the relation between physical activities and building elements, it is obvious that stairs have the real potential to influence an individual's fitness and health issues. These are part of almost every building and their usage is only a matter of choice and fitness. According to Zimring et al. (2005) there are two kinds of classifications of understanding the physical activity, Instrumental and Hybrid. A building in which there is no option of mechanical means of vertical transport, leads directly to the instrumental physical activity. Whereas an individual makes a choice of taking the stairs, for any number of reasons, then a stair climbing is neither instrumental nor purely recreational, but a hybrid of the two. They state that even a modest increase in the use of stairs can have positive health effects (Zimring et al. 2005). In this regard,

'The Harvard Alumni Health study of 11,000 men found that those who climbed at least 20 floors per week had a 20% lower risk of stroke. It has been suggested that two minutes of additional stair climbing per day would result in weight reduction of 1.2 pounds per year, more than eliminating the one pound per year average weight gain by U.S. adults' (cited in Zimring et al. 2005, p. 190).

According to Nicoll and Zimring (2009) there are two types of design strategies for promoting stair usage. Pull strategies that combine education, activity programs, and environmental interventions that make staircase use both appealing and habitual in existing buildings. Push strategies that are designed to obligate behavioral changes toward physical activity (Nicoll & Zimring 2009). The environmental push strategies require a fundamental change in the design of building typologies. Based on this approach, staircases are to be designed not only for vertical means of conveyance, but also as an encouragement for healthy life style.

It is not unusual to notice that a staircase is also used as an art installation, sculpture and as a landmark. Erickstad (2012) states that significance of stairs in art and photography seems to arise from the aspiration of transcendence to different planes of movement. An artist who utilized extensively the actual function and the inherent symbolic connotation of stairs in expressing multidimensional thinking patterns is M C Escher. He created an endless maze of different planes through his labyrinthine composition of stairs. Many of his drawings featured the illusion of never ending staircases and elevated the symbolic significance of stairs to a whole new level (Erickstad 2012). According to Alan and Blanc (2001) one of the noteworthy usages of stairs as art installations was by Louise Bourgeois. His exhibition of three sculptures at the New Tate Museum in 2000 received extraordinary attention and praise, in which staircase spirals around the central columns (Alan & Blanc 2001). The infinite staircase by artist Olafur Eliasson in the front of the KPMG accounting firm, Munich, Germany is one of the most intriguing form of interactive staircase installation. Ghose (2011) explains the presentation of Vivekananda speech by Jitish Kallat on the risers of the Grand Staircase of Art Institute's historic Michigan Avenue building. Illuminated by 68, 700 light emitting diodes in five colors, the speech starts at the beginning of the risers, progresses upwards and equally distributes among the three dispersing flights. A visitor experiences the visual and linguistic form of the entire speech irrespective of the flight chosen (Ghose 2011). This in stallation is of particular relevance because it integrates the practical, symbolic and spiritual connotations of steps and speech.

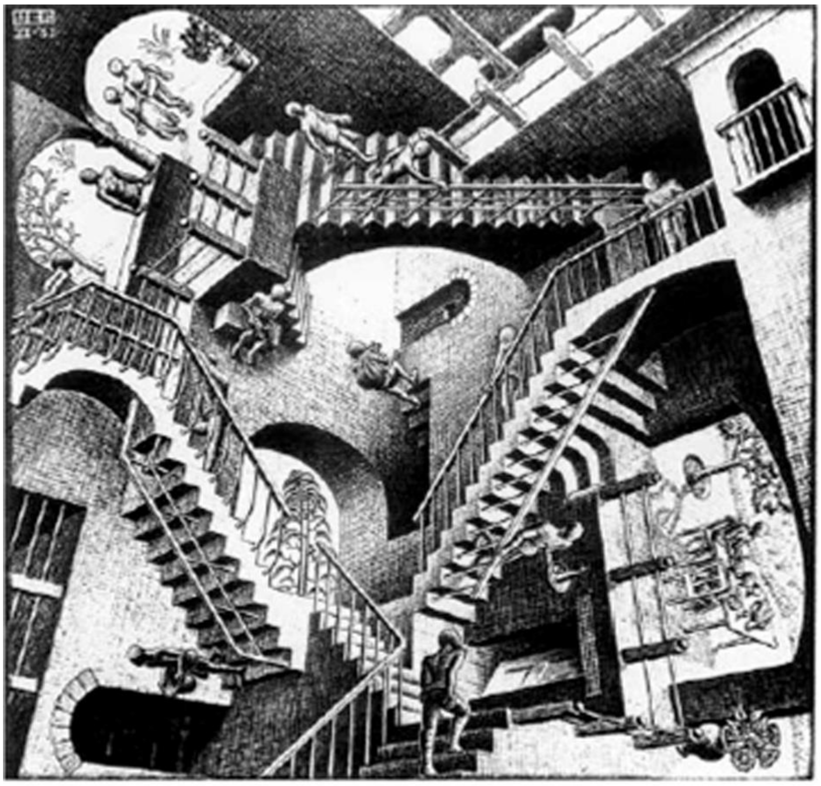

Figure 9.
An endless stair of vertigo. M. C. Escher, *Relativity,* lithograph, 1953. (Ernst, Bruno, *The Magic Mirror of M. C. Escher.* New York: Ballantine Books, 1976) *(Pallasmaa 2000, p. 13)*

Figure 10.
Sculpture by Louise Bourgeois for Tate Modern opening 2000 *(Alan & Blanc 2001, p. 200)*

Figure 11.
Jitish Kallat, preliminary design of Public Notice 3, May 2009, showing the sequencing of the text of Swami Vivekananda's speech up the flights of the Grand Staircase of the Art Institute of Chicago. *(Ghose 2011, p. 23)*

Advancement in technology coupled with the present style of architecture has redefined expressions of the staircase as light, floating, transparent and minimal. Even now significant civic architecture has steps as an iconic device. With the invention and innovation of new building materials staircases have become aspects of identity and structures of prominence. For example, the glass stairs with exposed structural elements in the Apple store have become the visual ambassadors of that brand across the globe (Erickstad 2012). Staircases are probably one of the few building elements that have the potential of maximizing the idea of display and identity. This is evident from the fact that the staircases are the fulcrum of interiors in many multi storied commercial centers. There is no exaggeration in assuming the role of stairs as perpetual, but their significance appears in new forms subjected to the changing dynamics of technology and perception.

Figure 12.
Olafur Eliasson – Rewriting, Munich, Germany *(Erickstad 2012, p. 67)*

Figure 13.
Apple Store – Fifth Avenue, New York (2006) *(Erickstad 2012, p. 77)*

DISCUSSION

Built forms relate people and the world in many different ways. They redefine the being both in terms of space and time (Pallasmaa 2000). The stepped arrangement or the stepped pattern is the only way to watch an event by a multitude of people at the same time. Even though the satellites can transmit live events across the globe with minor time differences, it is the stepped pattern that makes people to experience an event in real time and space. The stepped platforms allow performers to be seen, as well as creating tiered seating for spectators. It is the reason till date the auditoriums or stadiums or open air theatres are functioning and many new ones are being built. Surprisingly, even the present forms of the stadia and auditoriums are influenced by ancient Roman amphitheatres, because they exemplifying the basic design principles for maximum seating and maximum visibility (Erickstad 2012).

Steps are a universal symbol with multiple interpretations. They are the most generally used similes in art, philosophy and psychology. The mental significance and symbolic connotations of steps are deeply rooted. The feeling of safety in a stepped street is based on the subconscious fact that they are only for pedestrians (Pallasmaa 2000). Stairs convey a subtle feeling that they are not only for the physical connections but they also serve in elevating the human spirit. Templer (cited in Erickstad 2012) states that, staircases evoke a sequential experience by their very nature and each of its elements contribute in shaping the experience. For example, the size of the step controls user pace and behavior and landings create chances for interaction, contemplation, or an opportunity to observe (Erickstad 2012). Even though the stars are simple in their principle, they continue to occupy the imagination of architects, precisely because they should not only enhance the space, but also satisfy the intricate necessities of safety and comfort (eds Campbell & Tutton 2014). According to Scott (2005) the growing physical size of the younger population should be considered in deciding the minimum tread and riser dimensions. He states that, even with the number of detailed studies on stairway accidents, there is a dearth of credible information regarding the use of stairways by different age groups (Scott 2005). The issues involved with age based capabilities demand a certain design approach that satisfies the sensitive relation between built environments and building elements.

The mono functional approach to staircases in high-rise buildings, especially as the means of escape in emergency situations, indicates that the design of staircases as multi functional element is still under the confines of design explorations. Instead of proscribing the fixed usability, elements of architecture should cater to the needs of multiple functions and changing lifestyles (Sharr 2007). The advancement in technology has displaced the role of stairs into an inconsequential means of emergency escape. But the importance of physical activity in the rising sedentary lifestyle has revitalized the concept of stairs as an active building component. This has not only revived the waning value of stairs, but also enhanced its symbolic significance as an inspiration for physical well being.

CONCLUSION

The concept of vertical accessibility in the form of tread and riser arrangement makes stairs functionally a timeless phenomenon. The pattern of stairs is dependent on the type of materials and other related design considerations. Stairs occupy a unique status in the built environment because they not only convey people, but also symbolizes the psychological, spiritual and artistic aspects of human nature. The approach to multi utility architectural elements stretches beyond physical functions and should integrate the various dimensions of space making and society. In this regard stairs are a pioneering entity that has a potential to relate to many spheres of human thinking. It is clearly evident that stairs are not bound within the confines of architecture. Their origin, utility and design have far more influential qualities that travel beyond the realms of function and symbolism.

REFERENCES

Alan, and Blanc, S. (2001). *Stairs*. Oxford: Architectural Press.

Allen, E. (2005). *How Buildings Work: The natural order of architecture.* Oxford: Oxford University Press.

Berger, S. E., Theuring, C., Adolph, K. E. (2007). “How and when infants learn to climb stairs”, *Infant Behavior & Development,* 30: 36–49.

Bollas, C. (2000). “Architecture and the Unconscious”, *International Forum of Psychoanalysis,* 9(1-2): 28-42.

Campbell, J W P., and Tutton, M. (Ed.). (2014). *Staircases: History, Repair and Conservation*. England: Routledge.
Mellaart, J. (1962). "Excavations at Catal Huyuk: First Preliminary Report", *Anatolian Studies,* 12: 41-65.

Cirlot, J. E. (1971). *A Dictionary of Symbols*. England: Routledge.

Erickstad, S. (2012). *A Subconscious Ascent: Exploring the Architecture of the Metaphoric Staircase*. Unpublished Master's thesis, Victoria, Wellington: University of Wellington.

Ghose, M. (2011). "From Vivekananda to Kallat", *Art Institute of Chicago Museum Studies,* 36(2): 9-25.

Good, R. (2009). "Double staircases and the vertical distribution of housing in Venice 1450– 1600", *Architectural Research Quarterly,* 13 (1): 73-86.

Humphrey, C., and Vitebsky, P. (2003). *Sacred Architecture*. United Kingdom: Duncan Baird Publishers.

Juneja, M. (Ed.). (2001). *Architecture in Medieval India*. New Delhi: Permanent Black Publications.

Miles, M. M. (1999). "Interior Staircases in Western Greek Temples", *Memoirs of the American Academy in Rome,* 44: 1-26.

Nicoll, G., Zimring, C. (2009). "Effect of Innovative Building Design on Physical Activity", *Journal of Public Health Policy,* 30: 111-123.

Onians, J. (1992). "Architecture, Metaphor and the Mind", *Architectural History,* 35: 192-207.

Pallasmaa, J. (2000). "Stairways of the Mind", *International Forum of Psychoanalysis,* 9(1-2): 7-18.

Scott, A. (2005). "Falls on Stairways: Literature Review, Report Number: HSL/2005/10", Health and Safety Laboratory, England.

Sharr, A. (Ed.). (2007). *Heidegger for Architects*. England: Routledge.

Steadman, S. R. (2000). "Spatial Patterning and Social Complexity on Prehistoric Anatolian Tell Sites: Models for Mounds", *Journal of Anthropological Archaeology,* 19: 164–199.

Tanaka, H. (1992). "Leonardo da Vinci, Architect of Chambord?", *Artibus et Historiae,* 13(25): 85-102.

Wilkinson, C. (1975). "The Escorial and the Invention of the Imperial Staircase", *The Art Bulletin,* 57(1): 65-90.

Zimring, C., Joseph, A., Nicoll, G. L., Tsepas, S. (2005). “Influences of Building Design and Site Design on Physical Activity”, *American Journal of Preventive Medicine,* 28 (2S2): 186-193.

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