

**THE SIGNIFICANCE OF MATERIALS WITHIN THE CONTEXT OF
ARCHITECTURAL DESIGN**

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ABSTRACT

THE SIGNIFICANCE OF MATERIALS WITHIN THE CONTEXT OF ARCHITECTURAL DESIGN

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The assumption of this study is that material usage has the efficacy to influence the architectural language and building tectonics. The consideration for the transformative power of “materiality” in architecture has shifted as a result of developments in technology and science that have been rooted mostly in the Industrial Revolution. Throughout this research, changing relationships between materials and building tectonics as well as considerations for materials selection will be examined. As a result of this examination through literature review and comparisons of the case studies, this study aims to challenge the current tendencies that regard materials to be afterthought in the design process. Since the interrelatedness of materials and architecture as well as the “honest use of materials” have been disregarded to justify the transformation of the buildings into commodified objects to justify the appearance of facades for the profit motive, the “essence of architecture” that makes

buildings resist time, belong a particular context, give references to a specific period in history, region and culture seems lost. Therefore, it is the claim of this thesis that it is essential to prevent architecture from losing its compelling status as a discipline that ensures built environments with architectural identities through a complete perception of the significance of materials within the context of architectural design. Otherwise, it seems inevitable for architecture to become a stylistic manifesto of the employers and designers.

Keywords: materiality, materials selection, building tectonics, commodification of architecture

ÖZ

MALZEMELERİN MİMARİ TASARIM KAPSAMINDAKİ ÖNEMİ

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Bu çalışmanın temelindeki varsayım, malzeme kullanımının mimari dil ve yapı tektoniklerini etkileme kapasitesine sahip olduğu yönündedir. Çoğunlukla Endüstri Devrimi'ne bağlı olarak ortaya çıkan teknolojik ve bilimsel gelişmelerin sonucu olarak, maddeselliğin dönüştürücü gücünün değerlendirilmesi değişime uğramaktadır. Bu araştırma boyunca malzeme ve yapı tektonikleri arasındaki değişen ilişkiler ile malzeme seçimini etkileyen faktörlerin değişimi incelenecektir. Kaynak taraması ve karşılaştırmalı örnekler üzerinden yapılacak bu incelemenin sonucunda, bu çalışma malzemeyi sadece tasarım sürecinin sonunda karar verilen bir eleman olarak görme eğilimine karşı gelmeyi amaçlamaktadır. Günümüzde, malzemenin mimarlık ile birlikteliği ve malzeme dürüstlüğü kavramı, yapıları kar elde etme amacı üzerinden, dış görünüşleri ile metalaşmış objelere dönüştürmek adına göz ardı edilmektedir. Bu nedenler sonucunda, mimarlığın özü; zamana direnme, bir bağlama ait olma, belirli bir zamana, bölgeye ve kültüre referans verme gibi özellikleri kaybolmaktadır. Dolayısıyla; bu tezin savı, mimarlığın kimlik sahibi yapıları çevreler

oluřturma yolu ile edindiđi saygı uyandıran bir disiplin olma vasfını kaybetmemesi için malzemelerin mimarlık kapsamındaki öneminin tamamen kavranması gerektiđidir. Aksi takdirde bu disiplinin iřverenler ve tasarımcılar tarafından daha fazla para ve ün kazanma isteđiyle biçimsel bir söyleme dönüřtürülmesi kaçınılmaz olacaktır.

Anahtar Kelimeler: maddesellik, malzeme seçimi, yapı tektonikleri, mimarlığın ticarileřtirilmesi

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TABLE OF CONTENTS

ABSTRACT.....	v
ÖZ.....	vii
ACKNOWLEDGEMENTS.....	ix
TABLE OF CONTENTS.....	x
LIST OF FIGURES.....	xiv
LIST OF TABLES.....	xix

CHAPTERS

1. INTRODUCTION.....	1
1.1. Problem Definition.....	3
1.2. Aim of the Research.....	6
1.3. Research Methodology.....	8
1.4. Research Structure and Limitations.....	9
2. EVOLUTION OF THE MATERIAL USAGE IN ARCHITECTURE.....	11
2.1. Pre-Industrial Period.....	13
2.1.1. Material Options for Construction.....	15
2.1.2. Technological and Technical Limitations Regarding Material Selection.....	20
2.1.3. Limitations Related to the Architectural Language and Design.....	23

2.2. Industrial Period and Material-Related Shifts.....	25
2.2.1. Scientific and Technical Progress.....	27
2.2.2. New Materials and Construction Techniques.....	29
2.2.3. Mass-Production and Standardization.....	33
2.2.4. Major Influences of the Developments in Industrial Period on Architectural Language and Design.....	35
2.3 Post-Industrial Period and Material-Related Shifts.....	38
2.3.1. Contemporary Materials.....	41
2.3.2. The Advent of Computer-Aided Design.....	45
2.3.3. Mass-Customization.....	47
2.3.4. Major Influences of the Developments in Post-Industrial Period on Architectural Language and Design.....	50
3. THE TRANSFORMATIVE POWER OF MATERIAL USAGE IN RELATION TO THE LIMITS OF TECTONICS IN ARCHITECTURE.....	53
3.1. Direct Influence of Materials on the Building Tectonics.....	58
3.1.1. Chapel of Notre Dame du Haut, Ronchamp by Le Corbusier, 1954.....	61
3.1.2. Cathedral of Brasilia by Oscar Niemeyer, 1970.....	63
3.1.3. Indian Institute of Management Building by Louis Kahn, 1974.....	65
3.1.4. Thorncrown Chapel by E. Fay Jones, 1980.....	67
3.1.5. Vitra fire station by Zaha Hadid Architects, 1993.....	69

3.1.6. Church of Light and Sunday school by Tadao Ando, 1999.....	71
3.1.7. Sancaklar Mosque by Emre Arolat, 2012.....	73
3.2. Indirect Influence of Materials on the Building Tectonics.....	75
3.2.1. Strawberry Vale School by Patkau Architects, 1995... ..	76
3.2.2. Rosenthal Center for Contemporary Art by Zaha Hadid Architects, 2003.....	78
3.2.3. Solstice Arts Centre by Grafton Architects, 2006.....	80
3.2.4. Raif Dinçkök Yalova Cultural Center by Emre Arolat Architects, 2010.....	82
3.2.5. Dialogue in the Dark Bukchon by Wise Architecture, 2015.....	84
3.3. Independent Influence of Material on Architectural Language and the Building Tectonics.....	86
3.3.1. The Portland Building by Michael Graves, 1982.....	88
3.3.2. Clayton County HQ Library by Mack Scogin Merrill Elam Architects, 1988.....	90
3.3.3. The Guggenheim Museum Bilbao by Frank Gehry, 1997.....	92
3.3.4. Eberswalde Technical School Library by Herzog and de Meuron, 1999.....	94
3.3.5. Artistic amenity Stadshaard by Cie., 2009.....	95
3.3.6. Library of Birmingham by Mecanoo, 2013.....	97

4. DETERMINATIVE LIMITS OF THE MATERIALS SELECTION IN ARCHITECTURAL DESIGN PROCESS.....	101
4.1. Materials Selection According to Design Inputs.....	103
4.1.1. Physical Inputs of the Design and Their Relation to the Materials.....	104
4.1.2. Importance of Experiencing Materials' Properties....	109
4.2. Materials Selection Regarding Economical Considerations.....	114
4.2.1. The Influence of Market Economy on Architectural Design Decisions and Materials Selection.....	115
4.2.2. New Materials Selection Methods in the Age of Consumerism.....	119
4.3. Materials Selection Regarding Sustainability and Environmental Sensitivity.....	122
5. CONCLUSION: THE DECEPTION OF THE CURRENT MATERIAL USAGE.....	131
REFERENCES.....	137

LIST OF FIGURES

FIGURES

Figure 2.1 Sketch of the Primitive Hut construction in nature by Charles Eisen.....	14
Figure 2.2 Silbury Hill as the largest man-made earthen mound in Europe.....	16
Figure 2.3 (left) Westminster Hall timber roof.....	17
Figure 2.4 (right) Timber within the spire of Salisbury Cathedral.....	17
Figure 2.5 Exterior view of the Albi Cathedral.....	18
Figure 2.6 Sketch of the construction process in the Pre-Industrial Age.....	21
Figure 2.7 Log cabins in America as an example of the vernacular architecture.....	24
Figure 2.8 Grass huts in South Sea Isles as an example of the vernacular architecture.....	25
Figure 2.9 Interior of the Crystal Palace.....	32
Figure 2.10 Perspective drawing of “Maison Citrohan,” by Le Corbusier, 1921.....	35
Figure 2.11 Sketch of built environment in Industrial Period as seen by Pugin.....	37
Figure 2.11 Structural glass (composite material) stairs in the Danmarks Nationalbank.....	44
Figure 2.12 (left) Decker Yeadon’s homeostatic facade system (created with smart materials) which shifts and moves according to outside air’s temperature.....	44
Figure 2.13 (right) Cellulose nanocrystals which are used to produce stronger concrete.....	44

Figure 2.14 Greg Lynn, digitally produced embryological housing variations.....	49
Figure 3.1 Sculptural view of the Notre Dame du Haut Chapel in Ronchamp.....	62
Figure 3.2 Use of light on the smooth concrete walls of the Notre Dame du Haut Chapel in Ronchamp.....	62
Figure 3.3 Crown-shaped form of the Cathedral of Brasilia with the four bronze sculptures next to the building.....	64
Figure 3.4 Cathedral of Brasilia’s colored-glass roof that makes interior fully illuminated.....	64
Figure 3.5 General view of Indian Institute of Management Building.....	66
Figure 3.6 Brick arch of Indian Institute of Management Building.....	66
Figure 3.7 Thorncrown Chapel like a “forest within a forest”.....	68
Figure 3.8 Interior view of the Thorncrown Chapel.....	68
Figure 3.9 Exit door canopy of the Vitra fire station.....	70
Figure 3.10 Concrete walls, which bend, tilt, and break, of Vitra fire station.....	70
Figure 3.11 Light pouring from the cruciform cut in the concrete wall of the Church of Light and Sunday school.....	72
Figure 3.12 Stone roof and minaret of the Sancaklar Mosque.....	74
Figure 3.13 Tiered concrete ceiling of the prayer hall in the Sancaklar Mosque.....	74
Figure 3.14 Strawberry Vale School’s wood cladding that makes the building well-matched with the surrounding forest.....	77
Figure 3.15 (left), Figure 3.16 (right) Natural lighting of the Strawberry Vale School’s interior.....	78
Figure 3.17 Material usage on the facades of Rosenthal Center.....	79

Figure 3.18 Exterior view of Solstice Art Center.....	81
Figure 3.19 Grey-black marble mosaic slab over the civic space in uniformity with the surrounding buildings' roofs.....	81
Figure 3.20 Semi-transparent, rusty facade of Yalova Cultural Center.....	83
Figure 3.21 Closer view of the semi-transparent rusty material, which changes color by oxidation, used on Raif Dinçkök Yalova Cultural Center's facade.....	83
Figure 3.22 Exterior view of Dialogue in the Dark Bukchon.....	85
Figure 3.23 Interior view of Dialogue in the Dark Bukchon demonstrating different material usages.....	85
Figure 3.24 (left) Sketch of the duck, a special building as a symbol.....	86
Figure 3.25 (right) Sketch of the decorated shed, a conventional shelter that applies symbols.....	86
Figure 3.26 Portland Building with decorations on its facade.....	89
Figure 3.27 Traditional librarian box as the origin of the project.....	91
Figure 3.28 (left) 'Library' sign in front of the Clayton County HQ Library.....	91
Figure 3.29 (right) Painted in black and white corrugated steel covering on the exterior of the Clayton County HQ Library.....	91
Figure 3.30 Exterior view of the Guggenheim Museum Bilbao with non-structural metal cladding.....	93
Figure 3.31 Exterior view of the Weisman Art Museum in Minneapolis with non-structural metal cladding.....	93
Figure 3.32 Inconceivableness of the concrete and glass panels on the facade of Eberswalde Technical School Library.....	94
Figure 3.33 (left) Exterior view of the Artistic amenity Stadshaard in the district of Roombeek.....	96

Figure 3.34 (right) Example of the printed images on the facade.....	96
Figure 3.35 Exterior view of the Library of Birmingham.....	98
Figure 3.36 Intersecting circles on the facade of Armada Shopping Center in Ankara.....	98
Figure 4.1 Materials selection in the architectural design process.....	102
Figure 4.2 (left) Empire State Building, for which reinforced concrete that enables to construct high buildings, as an example of vertical line use.....	105
Figure 4.3 (right) Heydar Aliyev Center, for which glass fibre reinforced concrete and glass fibre reinforced polyester were used due to their plasticity that enable to construct curved forms.....	105
Figure 4.4 Kohl Children’s Museum as an example of form creating a space with the aid of light reflections through cladding material’s surface.....	106
Figure 4.5 Central St. Giles Court as an example of color added material usage in architecture.....	107
Figure 4.6 Therme Vals as an example of light creating the sense of depth through the surfaces of material used on the walls.....	107
Figure 4.7 (left) Masonry texture dominating the design in the House in Tinos.....	108
Figure 4.8 (right) Different textures of materials during the refurbishment of the West Tower in Huesca City Hall.....	108
Figure 4.9 (left) Roca London Gallery by Zaha Hadid Architects, application of the same operational logic in material process from furniture to the building.....	109
Figure 4.10 (right) Furniture, which is designed specifically, in the Roca London Gallery by Zaha Hadid Architects.....	109
Figure 4.11 Material library, Material ConneXion.....	112
Figure 4.12 Material applications in the Harvard University's Graduate School of Design.....	113

Figure 4.13 High-rise buildings in New York City.....	118
Figure 4.14 High-rise buildings in Dubai.....	118
Figure 4.15 Screenshot of three-dimensional model and material browser from Revit Architecture.....	120
Figure 4.16 Screenshot of material editor from Maya Maxwell.....	121
Figure 4.17 Turkish Contractor’s Association Headquarters.....	125
Figure 4.18 External mesh shading of the Turkish Contractor’s Association Headquarters.....	125
Figure 4.19 1315 Peachtree with plants and organic soil nearby.....	127
Figure 4.20 (left) Steel trellis and motorized shade system to protect the space from too much sun penetration.....	127
Figure 4.21 (right) Use of porous materials for region’s water issues.....	127
Figure 4.22 (left) ICEhouse by William McDonough.....	128
Figure 4.23 (right) Steel structure and exterior cladding of NASA Sustainability Base.....	128

LIST OF TABLES

TABLES

Table 2.1 Compared considerations of Pre-Industrial Period, Industrial Period and Post-Industrial Period..... 40

Table 3.1 Comparison of the three usages of materials according to their relatedness to the building tectonics, regarding architectural design intentions, considerations, production methods and outcomes in terms of architectural ‘spirit’ 99

CHAPTER 1

INTRODUCTION

Architecture differentiates from the other design disciplines such as graphic design or product design, by being connected with an exact place, history, culture, and values. It is defined by the poetic and structural powers of construction and not everything that encloses a space can be thought as a product of the architecture. To regard something as an architectural product, the embodiment of immeasurable, which is considered the “spirit,” should be provided.¹ This spirit or, in other words, architectural essence, which interrelates with the notion of “tectonic,” is formed by the subject of materials, and therefore architectural design can be described as the art of building through organizing materials and forms in a particular way to satisfy a specific purpose.² Throughout the history, the way of organizing materials and forms has altered. This change, under the different labels of “architectural styles,” such as International Style, Expressionism, Futurism, and as such, has arisen from the improvements in technology and science.³ It should be mentioned that, with the materials’ ability of expression, architects have presented their varying architectural

¹ See the definitions of architecture by John Ruskin, Le Corbusier, Sir Nikolaus Pevsner, and Louis Kahn as quoted in Paul- Alan Johnson. The Theory of Architecture: Concepts Themes & Practices, New York, Chichester, Weinheim, Brisbane, Singapore and Toronto: John Wiley& Sons, Inc., 1994, pp. 75-76.

² The term “tectonic” will be explained and discussed further in the third chapter of this study. See Kenneth Frampton. “*Rappel à L'ordre*: The Case for the Tectonic,” Labour, Work and Architecture: Collected Essays on Architecture and Design, London: Phaidon Press, 2002; Material Matters: Architecture and Material Practice, edited by Katie Lloyd Thomas, translated by Adrian Jackson, London and New York: Routledge, 2007.

³ See Reyner Banham. Theory and Design in the First Machine Age, 2nd edition, Cambridge, Massachusetts: The MIT Press, 1980.

ideas within the various ranges of formal, aesthetical or functional concerns in their projects.⁴ Even the ways of materials usage have been changed; the consideration of the proper use of materials should remain as the “*sine qua non*” of the architecture. In other words, an architect should be considered about materials, which shine amongst the other architectural components, through being an intimate part of the architecture⁵, about the history as well as the inherent qualities of materials.

According to John Fernandez, since the beginnings of architectural history, the main aim to construct buildings has been to provide delight and service. The buildings which can afford them provide improved daily activities and everlasting built landscapes as well as the reliable and durable shelters that ensure the safety and comfort of the occupants.⁶ As quoted by Fernandez, in “*De architectura*,” which is translated into English as “Ten Books on Architecture,” Vitruvius defines architecture as *firmitatis* and *utilitatis* that mean the services provided by buildings and *venustatis* as the delight or grace.⁷ Since Vitruvius’ period, there has been no essential change over time in the physiological needs of the humankind. However, economic and cultural factors, as well as the priorities of the society, have affected the balance between delight and service. People have expected higher comfort levels and varying pleasures.⁸ Therefore, delight and service have been evolved through the

⁴ Ibid.

⁵ For William Morris, while the use of materials is the most critical and intimate part of the architecture, there are other things which are considered architectural as well. These other parts, to which Morris alludes, will be regarded as the elements of architecture that will be explained in the fourth chapter of this study. See William Morris. “The Influence of Building Materials upon Architecture,” The Collected Works of William Morris with Introductions by his Daughter May Morris: Volume 22, Hopes and Fears for Art; Lectures on Art and Industry, Cambridge University Press, 2012, pp. 391-405.

⁶ John Fernandez. Material Architecture: Emergent Materials for Innovative Buildings and Ecological Construction, Italy: Elsevier Ltd., 2006, pg. 1.

⁷ Marcus Vitruvius Pollio. Ten Books on Architecture, translated by Ingrid D. Rowland, edited by Ingrid D. Rowland and Thomas N. Howe. Cambridge: Cambridge University Press, 2001, pg. 14, as quoted in Fernandez. Ibid.

⁸ Op. Cit., Fernandez, pp. 1-4.

ages due to changing elements of architecture including the materials. To couple delight and service into a symbiotic unit provides a fully different union of the design invention and engineering creativity that are created through the materials of the time. The information about building materials and subsidiary technologies has been expressed between cultural contexts since the beginning of the construction field. The knowledge of materials and construction techniques have been passed from well-informed practitioners to beginners through the written and printed sources, existing buildings and artifacts, and the methods with technical advancements that were improved within the last several centuries to ease the transfer.⁹

1.1. Problem Definition

The advancements in construction have always been and resume being to some extent due to changing conditions in the economy, technology, and culture. To investigate the evolution of materials and material knowledge, which have been improved over the past decades with the aid of industrial, scientific and social developments, is rewarding for the designers to make progress in the built world.¹⁰ Therefore, the relationship between the regard of materials and the architect or, in other words, the synthesis of the architect's design intention and the qualities of the materials that is termed as "materiality"¹¹ is essential.

In contemporary architecture, materiality, which has become a well-known architectural subject matter, is assigned to different meanings.¹² For example, while some architects regard materials as the medium of "the trivial identification of the

⁹ Ibid., pg. 2-20.

¹⁰ Ibid.

¹¹ See Victoria Ballard Bell and Patrick Rand, Materials for Architectural Design, London: Laurence King Publishing Ltd., 2006; Materiality and Architecture, edited by Sandra Karina Löschke. London and New York: Routledge, 2016.

¹² Op. Cit., Löschke, pg. 1.

aesthetic and beautiful,”¹³ which can be observed on high-profile public and commercial buildings, some others appreciate the materials through their inherent aesthetic values rather than one preternaturally created on material by design.¹⁴

Today, “material ethics as aesthetics” is more valid in architectural designs as a result of current “visual technologies, global media networks, and image-driven consumerism.”¹⁵ As mentioned by Banham, “most modern buildings appear to be made of whitewash or patent glazing, even when they are made of concrete or steel,”¹⁶ because of ‘the recent considerations of the consumerist society.’¹⁷ Derek Thomas, who terms the current period as the “Age of Consumerism,”¹⁸ says:

“The practice of present day architecture appears in a state of indulgence and in the business of self-gratification, even narcissism, rather than in the search for meaningful direction. Often there is a sense of alienation in the rarefied environments where architects 'strut their stuff' for their peers. Even though individualistic expression in architecture is almost a right, there is evidence that the needs of ordinary people are not always considered to be within the architect's terms of reference. Contemporary buildings and urban landscapes suggest not only a lack of cultural awareness but that of any environmental ethos, noticeable through the apparent disregard for the looming depletion of strategic natural resources. Although apathy towards real environmental issues can be seen as a reflection of the times, architects and urban designers should not ignore signals of global stress that are of significant social and ecological consequence. Not only architects and urban

¹³ Gernot Böhme as cited in Ibid.

¹⁴ Ibid.

¹⁵ The adjectives “visual technologies, global media networks and image-driven consumerism,” which describe the important directives of the current society and contemporary architecture, are borrowed from Ibid. pg. 2.

¹⁶ Reyner Banham. “The New Brutalism,” The Architectural Review 118, no. 708, December 1955, pg. 357 as quoted in Ibid.

¹⁷ ‘The recent considerations of the consumerist society’ mainly refers to the economical and environmental considerations in materials selection which will be discussed in more details in the fourth chapter of this study.

¹⁸ See Derek Thomas. Architecture and the Urban Environment: A Vision for the New Age, Oxford: Architectural Press, 2002, pp. 9-18.

designers, but societies at large must develop a more focused vision to meet the changed cultural and environmental paradigms of this, the New Age.”¹⁹

The new considerations in the architecture, which have affected the materials’ usage as well as the architectural design process and therefore have caused the lack of “cultural responses and a range of spatial experiences”²⁰ in architecture, of current society can be regarded to be rooted in the Industrial Revolution.²¹

“The Industrial Revolution, the abrupt increase in production brought about during the eighteenth century by the introduction of the factory system and the machine, changed the whole appearance of the world, far more so than the social revolution in France. Its effect upon thought and feeling was so profound that even today we cannot estimate how deeply it has penetrated into man's very nature, what great changes it has made there. Certainly, there is no one who has escaped these effects, for the Industrial Revolution was not a political upheaval, necessarily limited in its consequences. Rather, it took possession of the whole man and of his whole world.”²²

According to Fernandez, Industrial Revolution was started for social, industrial and economical interests while the scientific and technological advancements were the contributors to it. The revolutionary changes were led by improvements such as the development of machinery design and combustion engines, the progressions in organic chemistry, and the introduction of electric lighting as well as communication systems. Also, the nature of production was changed with the use of coal, oil and other fossil fuels that provide more energy than traditional fuels such as wood.²³ Therefore, the current “capitalist” world, in which materials have been considered to

¹⁹ Op. Cit., Thomas, pg. 9.

²⁰ Op. Cit., Banham, 1955, as quoted in Op. Cit., Löscke.

²¹ See Op. Cit., Banham, 1980; Sigfried Giedion. Space, Time and Architecture: The Growth of a New Tradition, 5th enlarged and revised edition, USA: Harvard University Press, 1967; Leonardo Benevolo. History of Modern Architecture, Vol. 1: The Tradition of Modern Architecture, first published in Italy in 1960, translated from the third revised Italian edition by H. J. Landry. Cambridge, Massachusetts: The MIT Press, 1996.

²² Op. Cit., Giedion, pg. 165.

²³ Op. Cit., Fernandez, pg. 23.

be aesthetic by being economic, affordable or industrial²⁴, has been shaped by the new means of production such as “standardization” interrelated with “mass-production” which have formed the new balances of the economy.²⁵

With the changes in material usage, the relationship between the architectural tectonic, which is described by Kenneth Frampton as “not only the structural component *in se* but also the formal amplification of its presence in relation to the assembly of which it is a part,”²⁶ and materials has changed as well. It can be proposed that as a result of “material ethics as aesthetics,” the current tendency “to reduce architecture to scenography”²⁷ has been observed in the architectural practices. Scenography, which is defined as “to describe something on stage” by Pamela Howard²⁸, has allowed designers to apply two-dimensional decoration to the building’s facades.²⁹ Therefore, this thesis indicates that the possibilities of materials to create narratives through the tectonic expression of the buildings have been neglected for the sake of production and consumption cycle in contemporary architecture.

1.2. Aim of the Research

Even ‘materiality’ has become favored architectural subject in contemporary architecture; the significance of material usage still seems to be underrated. According to Victoria Ballard Bell and Patrick Rand, in the academic realm and

²⁴ Op. Cit., Löscke, pg. 2.

²⁵ The new means of production will be discussed further in the second chapter of this study.

²⁶ Op. Cit., Frampton, pg. 93.

²⁷ Ibid.

²⁸ Pamela Howard as quoted in Enn Ots. Decoding Theoryspeak: An Illustrated Guide to Architectural Theory, USA and Canada: Routledge, 2011, pg. 183.

²⁹ Op. Cit., Frampton.

architecture schools, generally, the required materials and methods courses are separated from the design studios as if these two have little or no relationship between each other. In professional practice, same and even further misconception can be observed as well. In the design process, materials are considered as an afterthought like a color of paint applied to the building after the project has been developed. The materials are often selected at the end of the design process or even during the generation of construction documents for a building design. However, the design should be created by concerning the material and its properties to produce a successful project³⁰

For Sverre Fern, “each material has its own behavior, its own voice, and tells its own story, yet like a repertory theater, continuously engages and responds to the other members of its material troupe.”³¹ It can be said that an architect should understand the differences between physical qualities of different available materials, but more importantly, he should comprehend the significance of the materiality in the architectural design which would influence the whole perception of the built environment. According to Lisa Wastiels and Ine Wouters, a design project is not only produced for function and use but also for experience. The materials, which shape the environment, will significantly affect the occupant’s perception of that environment.³²

As comprehended insofar, materials should be regarded not just as the technical components of the architectural design, but rather as the enunciators of the architectural expressions and the essence of architecture itself concerning the tectonics. However, today, in the Age of Consumerism, material usage, of which significance has been devalued mainly due to the influence of the market economy

³⁰ Op. Cit., Bell and Rand.

³¹ Sverre Fern as cited in Andrea Simitch and Val Warke. The Language of Architecture: 26 Principles Every Architect Should Know, USA: Rockport Publishers, 2014, pg. 20.

³² Lisa Wastiels and Ine Wouters. “Material Considerations in Architectural Design: A Study of the Aspects Identified by Architects for Selecting Materials,” author deposited version, 2008, <http://shura.shu.ac.uk/511/1/fulltext.pdf>, (June 24, 2016).

on the architectural design process,³³ has become independent from architectural language and the building tectonics. Therefore, the aim of this study is to comprehend and to evaluate the altering relationship between material usage and contemporary architectural design process by tracing the origins and evolution of the material usage regarding the changing considerations of materials selection throughout the architectural history since Industrial Revolution.

Through the chapters of this study, it is proposed to answer the following questions: What is the current situation of materiality about the contemporary architecture? What have been the changing relations of the material usage to the architectural tectonics and design process? What have been the reasons and assistants of these dynamic relations? By answering these questions, this study aims to present and criticize the current connection of materials with the contemporary architecture.

1.3. Research Methodology

In order to provide a historical as well as a theoretical basis of the changing relations between materials and architecture the readings from relatively older times, mainly by Reyner Banham, Kenneth Frampton, Leonardo Benevolo, Jean Baudrillard and Robert Venturi, as well as the readings of recent vintage mostly, by Dick Parry, John Fernandez, Gail P. Borden, Leonard Bachman, Thomas Schröpher, Blanko Kolareviç, James Charles and Frederick Crane will be referred throughout this study. After literature preview is provided by presenting the altering connection of the materials to the architectural language and building tectonics in history, interpretations and critics on the stated problem of this research will be provided. Also, comparative case studies from 20th and 21st centuries of contemporary architecture regarding three different ways of material usage which are classified according to their influence on building tectonics as direct, indirect and independent

³³ The influence of the market economy on the architectural design process will be discussed in more details in the fourth chapter of this study.

will be done to criticize the latter one through exemplifying the significance of materials in architecture over the first and second usages.

1.4. Research Structure and Limitations

After the introduction part, the study continues with historical examination for the evolution of material usage and materials in architecture. The developments in science and technology as a result of Industrial Revolution and their effects on architecture will be discussed through literature review. In the third chapter, the issue of building tectonics will be explained in relation with the materiality in architecture. At the ends of each part in the third chapter, case studies selected from 20th and 21st century since the market economy, which has been the main factor that has affected the architectural design process and the connection between material usage and architecture, has been constituted as of the late 1950s³⁴, will be analyzed. Since ‘materiality’ has been a broad topic to discuss, it will be evaluated mainly within the frames of relationship between the theoretical basis on building tectonics as well as architectural language and materials. In the fourth chapter, the changing factors of materials selection, which are considered as physical design inputs, economical interests and the issues of environmental sensitivity and sustainability, will be explained with literature reviews and sampler case studies. In the last chapter, while the necessity to comprehend the significance of materiality and the critics on the current situation of materiality in architecture will be emphasized, thesis will be concluded.

In this research, throughout the case studies and discussions, the aim is not to explore the technical features of the materials and technical process of the materials selection nor to discuss the architectural style issues that have been current since the late 1950s. Instead, it is intended to provide a general perception about the significance of

³⁴ Daniel Bell as cited in Leonard R. Bachman. Two Spheres: Physical and Strategic Design in Architecture, London and New York: Routledge, 2012, pg. 4.

materials with regard to their communicative features in the current Consumerism Age that has shaped the new relations between materials and contemporary architectural design.

CHAPTER 2

EVOLUTION OF THE MATERIAL USAGE IN ARCHITECTURE

History is defined by Dr. Brooke Hindle, who worked as the Director of the National Museum of History and Technology, as the “collective memory”. For him, people recollect from the past whatever they need to operate for a given purpose at a particular time and what they need changes. To comprehend and solve ongoing problems history as the collective memory recalls the analysis of past events.³⁵ This statement is valid for the architectural history as well. As mentioned by Hazel Conway and Rowan Roenisch, examining the past is a helpful way to understand how society has arrived today. It provides perception about production and built environment.³⁶ Therefore, in order to understand the significance of materials in architecture, searching the evolution of material usage within a historical context is critical.

According to Gail Peter Borden, the materials and architecture are intertwined. Therefore, their historical background should also be regarded as interconnected. About this statement, he says:

“The history of architecture is the history of material application and invention. The use of new materials and the reinterpretation of existing materials have been at the root of architectural evolution. The formal and spatial developments in architecture

³⁵ Brooke Hindle. “How Much Is a Piece of the True Gross Worth?,” Material Culture and the Study of American Life, edited by Ian Quimby. New York: W W Norton & Co Inc., 1978, pg. 5.

³⁶ Hazel Conway and Rowan Roenisch. Understanding Architecture: An Introduction to Architecture and Architectural History, 2nd edition, Newyork: Routledge, 2005, pg. 33.

incurred through material exploration have yet to be fully documented. The role of material precedent, though essential to architectural education, design, and practice, has been overlooked and talked around.”³⁷

In similar with Borden, Lorraine Farrelly introduces that materials and construction techniques initialize architecture. Realizing the fact that the nature of materials and material usage has been changed throughout the time is significant. To create buildings, an architect should comprehend potentials and nature of the materials with a historical background. She states that:

“Materials create an ambiance and provide texture or substance to architecture. To understand how to use materials effectively, a designer needs to have an understanding of precedent or how materials have been used historically and an awareness of innovations in material application. Both can provide a useful way to develop a range of design approaches.”³⁸

To corroborate the statement that suggests architectural and material histories are intertwined, it is meaningful to look for the development of materials and construction in the historical context of architecture. Since the Industrial Revolution and the developments in science, as well as the innovations in technology, have been the keystones of advanced and new use of materials in architecture, the historical examination of materials with brief explanations and examples will be carried out in three parts which are Pre-Industrial Period, Industrial Period and Post-Industrial Period.³⁹ While historical information about all of these periods will be provided in the first chapter, the period that is focused throughout the study will be the latter one.

³⁷ Gail Peter Borden. Material Precedent: The Typology of Modern Tectonics, New Jersey: John Wiley & Sons, Inc., 2010, pp. 7-8.

³⁸ Lorraine Farrelly. Basics Architecture 02: Construction & Materiality, Lausanne: AVA Publishing SA, 2009, pp. 5-7.

³⁹ Statement based on literature reviews and discussions with Prof. Dr. Celal Abdi Güzer throughout this study.

2.1. Pre-Industrial Period

In order to explain the general requirements of the buildings for all architecture since from the very beginning of the history, Marc-Antoine Laugier presents the ‘primitive hut.’ In his “*Essai sur l’architecture*,” he explains that primary principles of architecture are based on the rules of nature. A primitive man acts upon his natural instincts and to protect himself from environmental factors such as sun and rain without burying himself; he constructs the built form as ‘primitive hut’.⁴⁰ Michael H. Mitias refers Laugier’s ‘primitive hut’ and questions how the caveman built the first house. He states that reason and building materials were his causes for constructing the hut. As quoted by him, for Laugier, primitive man was able to find trees and fallen branches, because he lived nearby a forest. By using these materials, he was able to construct a house for him to be sheltered.⁴¹ Similarly, with the ‘primitive hut’, the existence of materials and proper usage of them have been critical since Vitruvius. He says:

“In my first book, I have said what I had to say about the functions of architecture and the scope of the art, as well as about fortified towns and the apportionment of building sites within the fortifications. Although it would next be in order to explain the proper proportions and symmetry of temples and public buildings, as well as of private houses, I thought best to postpone this until after I had treated the practical merits of the materials out of which, when they are brought together, buildings are constructed with due regard to the proper kind of material for each part, and until I had shown of what natural elements those materials are composed.”⁴²

As comprehended, the construction techniques and building materials’ features have been an essential part of architectural learning beginning with Vitruvius. Vitruvius

⁴⁰ See, Marc- Antoine Laugier. An Essay on Architecture, translated by Wolfgang Herrmann and Anni Herrmann. USA: Hennessey & Ingalls, Inc., 1977, pp. 11-39.

⁴¹ Ibid., as quoted in Michael H. Mitias. “Is Architecture an Art of Representation?,” Architecture and Civilization, edited by Michael H. Mitias. Netherlands: Rodopi, 1999, pg.71.

⁴² Marcus Vitruvius Pollio. The Ten Books on Architecture, translated by Morris Hickey Morgan. Cambridge: Harvard University Press, 1914, pg. 36.

presented issues covering mathematical order and aesthetical subjects, city planning, the arrangement of the infrastructure, military fortifications and many topics regarding buildings. Among the many construction issues in Vitruvius's notable books, comprehending the related physical features of the primary construction materials is emphasized by him.⁴³ Fernandez spotlights this with a quotation from Vitruvius:

“Hence I believed it right to treat of the diversity and practical peculiarities of these things as well as of the qualities which they exhibit in buildings, so that persons who are intending to build may understand them and so make no mistake, but may gather materials which are suitable to use in their buildings.”⁴⁴

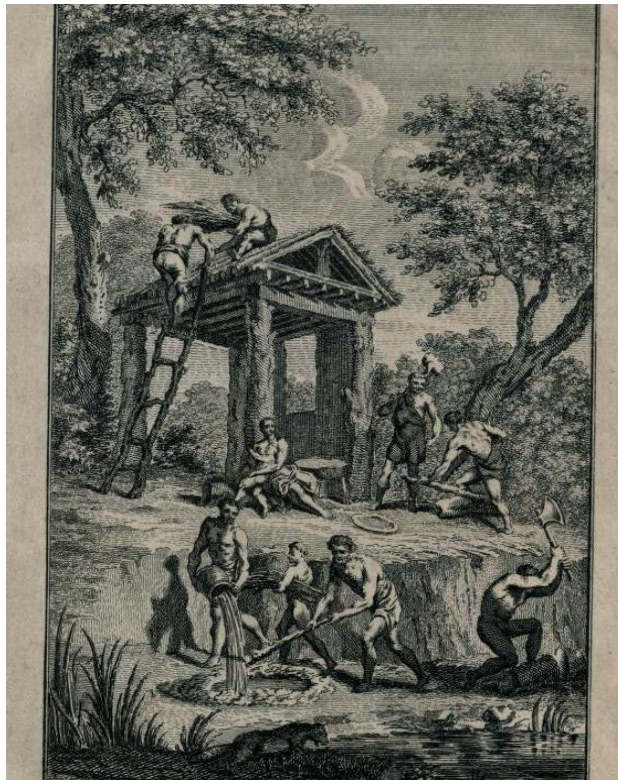


Figure 2.1 Sketch of the Primitive Hut construction in nature by Charles Eisen

Source: Marc- Antoine Laugier, Frontispiece to 2nd ed. of *Essai sur l'Architecture*, 1753.

⁴³ Op. Cit., Fernandez, pg. 20.

⁴⁴ Op. Cit., Pollio, 1914, pg. 42, as quoted in Fernandez. Ibid.

2.1.1. Material Options for Construction

Vitruvius points that selecting a suitable material for the buildings is critical for the construction of the intended form. However, the options for the materials were limited in the past. In his second book that he describes the materials and building methods, he mentions brick, sand, lime, pozzolana, stone, and timber which have been the local and traditional building materials.⁴⁵ Throughout the Pre-Industrial Period, these local materials, which were obtained from natural resources, were used in the natural form, in a changed form, in a combination or, in a form gathered from the naturally occurring materials to create works and structures.⁴⁶

According to Dick Parry, one of the materials that have been used since ancient times is earth. It has been a tool to build walls, ramparts, road pavements, barrows, ritual and defensive mounds, embankments, causeways, land reclamation and water retaining dams. It has been a supportive medium as well to build temporary ramps to raise large stone blocks. In many European countries, the earth was used as the primary or in between material of structures to keep, to control and to divert water such as irrigation, fish ponds, domestic supply and canals. Earth has also been the material beneath the foundation to consider.⁴⁷ For example, about the relation of foundations and the ground, Vitruvius makes suggestions as:

“The foundations of these works should be dug out of the solid ground, if it can be found, and carried down into solid ground as far as the magnitude of the work shall seem to require, and the whole substructure should be as solid as it can possibly be laid.... If, however, solid ground cannot be found, but the place proves to be nothing but a heap of loose earth to the very bottom, or a marsh, then it must be dug up and cleared out and set with piles made of charred alder or olive wood or oak, and these

⁴⁵ See, Op. Cit., Pollio, 1914, pp. 35-64.

⁴⁶ Dick Parry. Engineering the Pre-Industrial Age, Amberley Publishing Limited, 2013, e-book, chap. 2, par. 1, https://books.google.com.tr/books?id=kGmoAwAAQBAJ&printsec=frontcover&hl=tr&source=gbs_ge_summary_r&output=reader&pg=GBS.PP1, (April 9, 2016).

⁴⁷ Ibid., chap. 2, sec. Earth and Rock, par. 1-3.

must be driven down by machinery, very closely together like bridge-piles, and the intervals between them filled in with charcoal, and finally the foundations are to be laid on them in the most solid form of construction. The foundations having been brought up to the level, the stylobates are next to be put in place.”⁴⁸

Timber is the second material, Parry continues, that has been widely used since the Pre-Industrial Age. It was easy to find in nature, and it provided easiness in work and superior strength properties in tension, compression and bending in comparison with other available materials. Therefore, it provided main structural elements for buildings. He adds that it was also a subsidiary part in construction for scaffolding that provided temporary or sometimes permanent access. As told by Parry, the joining of timber members was used in framed structures such as roofs. In medieval architecture, ridged timber roofs can be seen. Another example of timber use can be found in wooden piles of wharves and weirs, and foundations of buildings and bridges from as early as Roman times. Wooden piles have been used since antiquity in vast amounts and for different purposes. It is also possible to observe the composite use of timber with other materials in masonry or brick structures in which wood was used for tie beams which can be mainly seen in Byzantine architecture.⁴⁹



Figure 2.2 Silbury Hill as the largest man-made earthen mound in Europe

Source: English Heritage, <http://www.english-heritage.org.uk/visit/places/silbury-hill/>, (April 11, 2016)

⁴⁸ Op. Cit., Pollio, 1914, pp. 86-88.

⁴⁹ Op. Cit., Parry, sec. Timber, par. 1-11.



Figure 2.3 (left) Westminster Hall timber roof

Source: “Gothic Architecture,” <http://www.peartree-miniatures.co.uk/topics/gothic.html>, (March 27, 2016).

Figure 2.3 (right) Timber within the spire of Salisbury Cathedral

Source: <http://www.geograph.org.uk/photo/4095459>, (March 27, 2016).

Another material is brick which is discussed by Parry.⁵⁰ For Yglesias, its use has been seen from at least 10,000 years ago. It was used in ancient Mesopotamia and Africa for the construction of early ziggurats and sometimes interior chambers. In Greek and Roman cities, brick was used in a widespread manner as well.⁵¹ For Parry, brick can be noticed remarkably in Byzantine architecture, and it was used to construct mosques, palaces and fortresses by Islamic builders as well. With the Islamic structures such as the Mosque of Córdoba and the Alhambra Palace that present a splendid visual impact, the return of the bricks to Western Europe can be observed. This result was provided with a technique, which was learned from the Persian Sassanians, to create decorative bricks. Mosque at Kairouan in Tunisia and the Ibn Tulun Mosque are the other notable representatives of early Islamic brick buildings. Byzantine builders who made many creative applications of burnt brick had affected the techniques used by Islamic builders either, which can be recognized

⁵⁰ Op. Cit., Parry, sec. Brick.

⁵¹ Caren Yglesias. The Innovative Use of Materials in Architecture and Landscape Architecture: History, Theory and Performance, North Carolina: McFarland and Company, Inc., Publishers, 2014, pg. 57.

especially in mosaics, and affectional patterns that were created with glazed tile work, stucco and burnt brick mosaics.

Parry adds that, in the eleventh century, Romanesque buildings mostly constructed with brick under the influence of Byzantine architecture had started to become current in northern Italy followed by the Alps, France, the Low Countries and ultimately Britain in the thirteenth century. In medieval times, brick was used in many parts of Europe for buildings such as the Marienkirche in Lübeck or the Albi Cathedral, which is asserted as the world's largest brick⁵², in the southwest of France. As of the fifteenth century, brick was commonly used for structural elements and ornamentation in England.⁵³



Figure 2.5 Exterior view of the Albi Cathedral

Source: George Gerald Girling Saunders. 1965, <https://www.architecture.com/Explore/Revealingthecollections/AlbiCathedral1965.aspx>, (July 14, 2016).

⁵² Ibid., par. 7.

⁵³ Op. Cit., Parry, sec. Brick, par. 1-9.

The fourth issue which is discussed by Parry is masonry for which igneous, sedimentary and metamorphic rocks provides the stone which has been used since the ancient times for the construction elements such as walls, mass structures, columns and lintels, masonry arches, vaults, and domes.⁵⁴ The upright boulders in Stonehenge which have been dated to around 5000 BCE are the earliest surviving stone constructions.⁵⁵ The stone-built dwellings in the Skara Brae site in Orkney, the Great Pyramids of Giza, Parthenon in Greece are the other significant structures from the earlier times.⁵⁶ Parry mentions that sandstone and limestone have been the two most usual sedimentary rocks because of their mere existence and feature as to be effortlessly quarried and shaped. Marble and granite which are members of the metamorphic rocks were other building materials that were used in the ancient world as facings and decorative elements, or for columns and lintels.⁵⁷

The last building material, Parry continues, in the context of Pre-Industrial Age is mortar which has been a mixture of several substances such as mud or moistened earth case by case combined with straw or reeds, pitch, gypsum, a combination of sand and lime or sand and cement in history. Binding together the bricks or masonry has been the primary function of mortar.⁵⁸ In Greek cities, mortar with lime, which can also be seen in Roman buildings, was used instead of weaker mortars such as gypsum plaster or bitumen. The Roman builders also added crushed volcanic ash to lime and this mixture was later called pozzolanic cement.⁵⁹ According to Nicholas Winter, crushed brick or tile was used in places such as Britain because of the

⁵⁴ Ibid., sec. Masonry, par. 1-9.

⁵⁵ Op. Cit., Yglesias, pp. 102-105.

⁵⁶ Op. Cit., Farrelly, pp. 15-17.

⁵⁷ Op. Cit., Parry, sec. Masonry, par. 2-9.

⁵⁸ Ibid., sec. Mortar, par. 1.

⁵⁹ Bamber Gascoigne. "Cement," HistoryWorld, from 2001, ongoing, <http://www.historyworld.net/wrldhis/PlainTextHistories.asp?groupid=1523&HistoryID=ab27>rack=pthc>, (April 11, 2016).

hardness in finding volcanic ash. Mainly about the lack of cement in mortars which formed with lime instead, the building skills in Europe could not be developed after the Romans.⁶⁰ Parry adds that, up to the nineteenth century, sand and lime mortar was used by medieval and post-medieval builders. By the invention of Portland cement in 1824, mortar became harder and stronger, but more brittle material.⁶¹

2.1.2. Technological and Technical Limitations Regarding Material Usage

As discussed in the previous section, designers had limited options in materials throughout Pre-Industrial Age. The buildings were constructed with known and available materials. According to Borden, the distance of transportation which made material selection dependent to a place and region, the limited sources of work labor in construction and the technology of local craft with the knowledge of materials that passed down through cultural generations were other limitations.⁶² About this restriction of the material choice, Ken Ward-Harvey says:

“The history of Architecture and Building goes back thousands of years, and the major changes termed "styles" have been closely associated with the materials available and technologies learnt by tradesman to construct those outstanding buildings which have come down to us as great examples of past Architecture. The materials were mainly timber or derived from plants; stones and ceramics such as bricks and other forms of baked clay products. Changes were usually slow and easily passed on by the tradesmen, who were largely limited to the Carpenters, Stonemasons, and Bricklayers.”⁶³

⁶⁰ Nicholas B. Winter. “Cement History,” Understanding Cement, 2005, <http://www.understanding-cement.com/history.html>, (April 11, 2016).

⁶¹ Op. Cit., Parry, sec. Mortar, par. 1.

⁶² Op. Cit., Borden, 2010, pg.8.

⁶³ Ken Ward-Harvey. “Preface to 2009 Edition,” Fundamental Building Materials, 4th edition, USA: Universal Publishers, 2009.

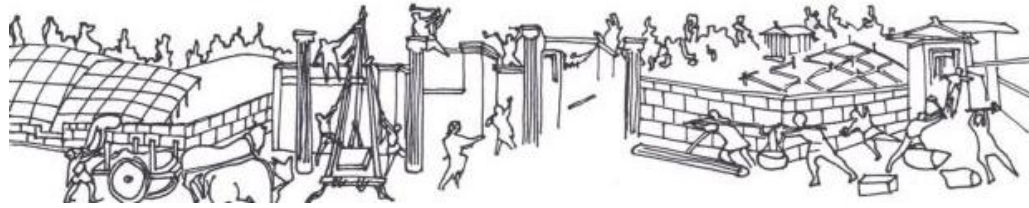


Figure 2.6 Sketch of the construction process in the Pre-Industrial Age

Source: <https://story.dirty.ru/rimskie-krany-607851/>, (March 27, 2016).

For Parry, during the Pre-Industrial Age, the main available source of power was provided by humans and animals using simple mechanical tools such as a lever, picks, chisels, wedges, wheeled carts or wagons and so on. In operations such as excavating or shaping stone, cutting down timber, transportation of the building materials, lifting or positioning, water power and in some particular cases wind power were used.⁶⁴ For example, Matthew Slocombe mentions that, for the construction of Waltham Abbey in Essex, which required a significant amount of stone in 1218, the transportation of the stone, which was extracted from a quarry near Reigate in Surrey, was performed with a specially built wharf at Battersea and along the Thames. This example shows that to transport stone for significant distances from the quarry site was a considered issue in the Pre-Industrial Age. 10-20 miles from the quarry site was the furthest distance to carry before the late eighteenth century, and this transportation process would require considerable effort where the terrain was hard to overpass.⁶⁵

As mentioned by John Murdoch and Will Hughes, in Pre-Industrial Period, the number of the available construction techniques, which include bricklaying, carpentry, thatching and stonemasonry, was limited. In general, craft skills were used in building projects while an architect was required to design the building. Therefore,

⁶⁴ Op. Cit., Parry, chap. 2, sec. Tools and Techniques.

⁶⁵ Matthew Slocombe. Traditional Building Materials, Shire Publication, 2012, pg. 21.

the evolution of the buildings was slow, and the knowledge gained by the experience from previous works led slight modifications in new projects.⁶⁶

For Parry, the designer who would be Master Builder later needed to have many years experience on the job by examining the major works or sometimes being involved in the construction process. A lot of sons followed their parents into the building field, and they gained the knowledge of construction when they were at an early age. Transferring the knowledge acquired from experienced builders or getting involved in the construction were the main ways to learn different building methods and one of the reasons of this may be the absence of movable-type printing which was introduced in Europe around 1452. Before this, making sketches of construction techniques and various tools and taking notes on parchment were the methods to store information. Most of the documents of master builders and experienced masons had perished, while some of them have been preserved such as exceptional sketches and notes documented by the French master mason Villard de Honnecourt.⁶⁷

The publications dating back to Ancient Rome was also important to learn construction techniques as mentioned before. Since Vitruvius, the features of building materials and construction methods have been an important method in architectural learning.⁶⁸ The writings and sketches of following outstanding figures, who are regarded as “the creators” by Parry, such as Abbot Suger, Villard de Honnecourt, H. Yevele, F. Brunelleschi, Battista Alberti, Giorgio Martini, Sangallo Brothers, Leonardo da Vinci, M. Buonarroti, Sinan, C. Vermuyden, P. Riquet, C. Wren, Sèbastien Le Vauban, J. Perronet, and J. Smeaton, have played a significant role in documenting the knowledge as well as the inventions in construction field.⁶⁹

⁶⁶ Will Hughes and John Murdoch. Construction Contracts: Law and Management, 3rd edition, London: Spon Press, 2000, pg.2.

⁶⁷ Op. Cit., Parry, chap. 1, sec. The Creators, par. 1-2.

⁶⁸ Op. Cit., Fernandez, pg. 20.

⁶⁹ See, Op. Cit., Parry, chap. 1.

2.1.3. Limitations Related to the Architectural Language and Design

In this period, the restriction in the material choices, as well as the technological and technical limitations, affected architectural language as discussed insofar. For example, according to Angus Macdonald, the masonry vault and the dome were used to construct the widest spans in this period. Another structural material was timber for buildings as mentioned in the previous parts and it was hard to provide joints in timber to construct wooden structures from the small size of individual timbers. Therefore, large-scale structures were backbreaking to build. Since the lack of satisfactory joint technology and method to produce efficient fully-triangulated trusses, the sizes of the buildings were restricted.⁷⁰

As mentioned by Mark Gelernter, the number of floors and therefore the heights of the buildings were limited to maximum four or five. Because higher masonry wall requires more thickness at the base that means the loss of a remarkable percentage of the floor area on the ground, tall masonry buildings were not favorable to construct. Because the windows and doors, in other words, the openings on the outer walls cause weakness in the load-bearing masonry walls, their sizes were limited as well. As mentioned in the previous paragraph, the length of the span that is supported by stone beams or arches were restricted and even it was possible to build larger openings, the cost and limited size of glass constituted an impediment to construct them. The larger openings also caused more heat loss. Therefore smaller openings were more preferred in this period.⁷¹

At this point, within the frame of architectural design and visual uniformity, which was led by the technical and technological restrictions as well as the material limitations, of this period, ‘vernacular architecture’ should be mentioned, although it

⁷⁰ Angus J. Macdonald. Structure and Architecture, 2nd edition, Oxford: Architectural Press, 2001, pg. 86.

⁷¹ Mark Gelernter. A History of American Architecture: Buildings in Their Cultural and Technological Context, United Kingdom: Manchester University Press, 1999, pg. 153.

is a broad topic which will not be discussed further in this study. George Walter Born describes vernacular architecture as “the traditional building of the ordinary people at a particular time and place,” and mentions that its strictest definition refers to the modest buildings of the Pre-Industrial Age. He explains that vernacular design aimed to provide practical and functional concerns instead of regarding aesthetics and the occupant or a builder with no formal architectural training was the designer. The architectural plans were not thoroughly detailed and tried patterns were applied in the designs. The use of indigenous materials provided distinctive regional building traditions.⁷²



Figure 2.7 Log cabins in America as an example of the vernacular architecture

Source: Eric Hegg. 1897, <http://www.skagitriverjournal.com/WestCounty/NW/Colony/Equality02-RJordan.html>, (August 8, 2016).

⁷² George Walter Born. Preserving Paradise: The Architectural Heritage and History of the Florida Keys, London: The History Press, 2006, pg. 13.



Figure 2.8 Grass huts in South Sea Isles as an example of the vernacular architecture

Source: Imelda Miller. 1904, <http://www.qhatlas.com.au/content/sugar-slaves>, (August 8, 2016).

Consequently, it can be said that architecture of this period, including vernacular one, presented the limited choices of texture, mass, scale and solid to void proportion due to structural and material limitations. Although variation in architecture was observed as well, which can be exemplified with medieval half-timbered houses in comparison with the grand Gothic and Baroque cathedrals, the similarities of construction and materials were more dominant than the differences. This situation led to a visual uniformity which can be observed in older parts of European cities such as London, Paris, Rome and Venice, and in the older parts of American cities like Boston today.⁷³

2.2. Industrial Period and Material-Related Shifts

Lester Wertheimer describes the Industrial Revolution, in brief, as the replacement of human labor with the machine power. It emerged in England and its process beginning in the late 18th century with the invention of the steam engine by

⁷³ Op. Cit., Gelernter.

Scotsman James Watt had been slowly evolving for many years. It had started to be used in mines, mills, and factories in which it provided to ease the same amount of production with less time and cost than required to produce with men power. With the Industrial Revolution, machines and engines started to rule the world. The use of iron, coal, and steam as well as the railroads and steamships became widespread. While improved communications and faster travel options were changing the world into a smaller one, life was getting easier with the inventive new machinery. The ingenuity of the people started to be seen unrestricted.⁷⁴

The profound effect of machines connected with the Industrial Revolution can be regarded as the main reason for Reyner Banham to entitle his book on architecture and design as “Theory and Design in the First Machine Age,” while he refers the early 20th century by “First Machine Age.” It was a time when electricity and lighting, electrical devices, automobiles and portable typing machines have started to be commonly used.⁷⁵ As Le Corbusier says:

“By slow degrees the building sites will become industrialized, and the incorporation of machines into the building industry will lead to the introduction of standard components; house designs will change, a new economy will be established; the standard components will ensure unity of detail and unity of detail is an indispensable condition of architectural beauty...Our towns will lose the look of chaos which disfigures them today. Order will reign and the network of new roads, from an architectural point of view, will provide us with splendid views. Thanks to the machine, thanks to standard components, thanks to selectivity, a new style will assert itself.”⁷⁶

In similar with Banham, Leonardo Benevolo mentions the effects of Industrial Revolution on architecture regarding both theory and practice. According to him, the birth of modern architecture, which implies a new range of forms as well as new way

⁷⁴ Lester Wertheimer. Architectural History, USA: Kaplan AEC Architecture, 2004, pg. 74.

⁷⁵ See, Op. Cit., Banham, 1980.

⁷⁶ Le Corbusier, as quoted in Gregory L. Demchak. “Towards a Post-Industrial Architecture: Design and Construction of Houses for the Information Age,” unpublished master thesis, Massachusetts Institute of Technology, 2000, pg. 19.

of thinking, can be caused by the Industrial Revolution's effects on building and town-planning.⁷⁷ Although the connection between revolutionary social, economic and technical changes in architecture is not immediately evident, as quoted by Benevolo, the description of architecture by William Morris explains that it was unimaginable for architectural design, which is directly related to human life, not to be affected by Industrial Revolution.⁷⁸ Morris says:

“Architecture embraces the consideration of the whole external surroundings of the life of man; we cannot escape from it if we would so long as we are part of civilization, for it means a moulding and altering to human needs of the very face of the earth itself, except in the outermost desert.”⁷⁹

Even the main center of this study is not to discuss the history and the content of modern architecture as carried out by Benevolo, the historical context of this period, which has led the modern design as explained by him, also caused the scientific and technical progress. These advances provided the invention of new materials, production and building techniques. Therefore, the material-related changes in architecture will be discussed mainly by referring Benevolo.

2.2.1. Scientific and Technical Progress

In this period, the centers of production were shifting, and industrial capacities were increasing while scientists and technologists were contributing to the revolution incrementally and slowly. The works of individuals and especially the studies on statics and the strength of materials provided a consensus about the efficient form and use of materials.⁸⁰

⁷⁷ See Op. Cit., Benevolo.

⁷⁸ Op. Cit., Benevolo, pg. x.

⁷⁹ William Morris as quoted in Ibid.

⁸⁰ Op. Cit., Fernandez, pp. 23- 24.

With the improvements in geometry, empirical and theoretical tools, the growing articulation of physical principles affected the forms of architecture.⁸¹ As Benevolo says, scientific progress provided the utilization of the materials in a more apt way while it also ensured the calculation of the materials' strength. The machinery and better equipment started to be used on building sites and the definite plans for the construction were provided with the aid of developments in geometry. Specialized schools, where professionals would be trained, were set up. The new methods of graphic reproduction and printing contributed to the construction of buildings.⁸²

For Benevolo, the science of building, which can be considered to be born in the seventeenth century with the Galileo's dialogues about the stability, is a field of study that concerns settled practical outcomes of the laws of mechanics. The experimental researches, studies on statics and strength of materials, the discovery of general equation to determine neutral axis and as such, were the outcomes of the spread of the scientific spirit and the architects' intentions to find the limits of the use of traditional building materials and techniques.

During the first decades of the nineteenth century, Louis-Marie Navier, who is regarded as the founder of modern constructional science, organized and perfected the results of these studies. With the constructional science, theoretical and practical involvement was separated. The alternative methods and forms were provided in addition to the inherited ones from antiquity. Building techniques and instruments of planning were modified with the conception of the descriptive geometry of which rules were explicated by Gaspard Monge and the introduction of the metric system. With the unified system concerning measurement, the spread of the knowledge was eased while the building technique with a typical device of which precision could be advanced according to the new techniques' requirements was provided.

⁸¹ Ibid.

⁸² Op. Cit., Benevolo, pg. 3.

The Revolution also affected architectural teaching by the foundation of new schools which caused the establishment of the rivalry between ‘architects’ and ‘engineers’ by organizing technical teaching which strengthened the engineer’s position. England was the exception where this organization of technical education was only realized during the last decade of the nineteenth century. Therefore, the controversy between architects and engineers was less rigid in there. For Benevolo, this was the main reason for that it was in England where men were frequently interested in different activities of various fields. He tells that even in England, the division between architects and engineers became evident especially after 1830. Technical progress and advancements required the specialist technicians to complete professional projects.⁸³ As Fernandez mentions:

“These advances led to the establishment of two conditions that were to change the nature of the relationship between the architect, construction techniques and the materials of construction. First, the delineation of the discrete domains of study for the inventor of construction techniques and materials meant that the nonarchitect could make strides forward in improving, and profiting, from new technologies for realizing buildings. This continues today. Many individuals involved in building sciences are not architects and the proportion of nonarchitects is only likely to grow. Second, these individuals would begin the process of the founding of two of the dominant organs for research, development and manufacturing of building materials; the private corporation and the academic building science research department. This quickly led to the development of separate and distinct disciplinary languages focused on rapidly diverging interests.”⁸⁴

2.2.2. New Materials and Construction Techniques

According to Benevolo, construction techniques and materials started to be advanced or replaced with new ones in Industrial Age. While stone, brick, and timber were now utilized with more profit and transported more easily, new materials such as cast iron, glass and, later, concrete were added in the material options. He adds that, in

⁸³ Ibid., pp. 5-12.

⁸⁴ Op. Cit., Fernandez, pg. 24.

the eighteenth century, to build new and efficient means of transportation such as roads and canals became critical. Especially, during the first years of the nineteenth century, the buildings of roads by governments for commercial and strategic functions, bridges, and canals by individuals to provide ways for transportation of the raw materials and the goods, became more intense. With the new scientific knowledge about materials, it was possible to use the limits of their possibilities that caused the application of traditional materials such as wood in an advanced way as well as the use of new materials such as iron and cast iron.⁸⁵

Iron and glass, which had been worked within buildings since time immemorial, are the first two materials which are mentioned by Benevolo. With the industrial progress, their uses were advanced with new concepts and building techniques. Before these advancements, iron was used as a subsidiary element such as braces, chains, and to combine the hewn stone in freestone buildings. It was also used for roofs that did not carry very much weight which is exemplified by Benevolo with the *Theatre Français de Bordeaux* which was designed by Victor Louis. However, these methods could not spread because of the limited operations made in the iron industry. The improvements made in England increased the iron production. Cast iron and ductile iron started to be obtained. By smelting steel, a higher-level material was gained in 1740 and after the middle of the eighteenth century, these findings were well-known.⁸⁶

According to Benevolo, by helping to advance the steam engine and studying developed systems of using cast iron for industry, John Wilkinson, who also possibly had the idea of the first iron bridge which was built from 1777 to 1779 on the Severn at Coalbrookdale, promoted the technical application of iron in the history. After that other iron bridges were built such as Sunderland Bridge over the Wear in 1796 and a second bridge over the Severn, at Buildwas in the same year. These bridges were built with larger spans, less weight, and quicker execution. In the first three decades

⁸⁵ Op. Cit., Benevolo, pp. 3-12.

⁸⁶ Ibid., pp. 12- 19.

of the nineteenth century, cast iron started to be used more commonly in buildings. For many industrial buildings, cast-iron columns and girders were used. The use of cast iron for example in the Royal Pavilion at Brighton in 1818 or the Doric columns of Carlton House Terrace in 1827 provided remarkable improvements in English iron industry. During the eighteenth century, the use of iron and cast iron was not common on the Continent. With the Napoleonic regime of the first years of the nineteenth century, French iron industry started to be developed which make possible to build large-scale works in iron such as the Pont des Arts and the dome of Halle au Blé. The use of iron became common in France after the Restoration. He continues with explaining that the idea of suspension bridges with chain cables emerged at the end of the eighteenth century. A pedestrian footbridge over the Tees dated 1741 is the first known example. Other examples include; the bridge across the Tweed, the Menai Bridge, the Tournon Bridge over the Rhone, the Bridge over the Saane at Fribourg, and the Clifton Bridge over the Avon at Bristol.⁸⁷

According to Benevolo, iron buildings have reached the limits of their possibilities in the second half of the nineteenth century. He mentions several buildings including the Crystal Palace, the Galerie des Machines and the Eiffel Tower, which are the examples of rapid progress made in iron construction.⁸⁸

The second material is glass, Benevolo mentions, of which use was advanced in the second half of the eighteenth century. The Napoleonic wars made difficult to develop the production of glass in England where the large part of glass production took place. After the peace treaty, the consumption and production of glass increased in England and the use of glass became universal for windows and doors while it was also used with iron at roofs to let in the light. In the Industrial Period, the use of glass started to be applied in public buildings such as the glass cover of Galérie d'Orleans of the Palais Royal, which was the prototype of nineteenth-century glass galleries. It was also used for some large conservatories such as the Paris Jardin des Palmes in

⁸⁷ Ibid., pp. 19-20.

⁸⁸ Ibid., pp. 96- 124.

1833, the Chatsworth in 1837, the Kew Gardens in 1844. The Champs Elysees in Paris, which turned into a public gathering place, was another example to these conservatories. Huge glass roofs were used for first railway stations while architects designed walls entirely of glass and enormous windows for the new shops.⁸⁹ According to Benevolo, all the experiments of glass usage were summarized by the Paxton's Crystal Palace of 1851 and this building had led the way of great series of glass exhibition galleries of the Second half of the nineteenth century.⁹⁰



Figure 2.9 Interior of the Crystal Palace

Source: Brent Richards. New Glass Architecture, USA: Yale University Press, 2006, pg. 14.

Another material to be discussed is reinforced concrete which Benevolo regards as a paramount building material especially after the publication of building codes because of being economical.⁹¹ D. Watt and P. Swallow mention that concrete has

⁸⁹ Op. Cit., Benevolo, pp. 21-23.

⁹⁰ Ibid., pg. 23.

⁹¹ Op. Cit., Benevolo, pg 118.

been used since the ancient times. However, it had not been in use commonly for an extended period after the fall of the Roman Empire. In the eighteenth century, the use of concrete re-emerged with the lighthouses and other marine structures that were constructed on difficult sites with challenging conditions.

With the invention of Portland cement by Joseph Aspdin in 1824, the productive use of modern concrete began while in the early 1830s reinforcing Portland cement concrete started.⁹² In the book entitled “Concrete Construction Manual,” the authors mention that the earliest practical use of this new material which permitted to apply new building methods was realized for the industrial and commercial buildings where larger spans were needed. The Hennebique system and Ransome's structural system were among these new approaches which were started to be used at the end of the nineteenth century. For the authors, Auguste Perret became the precursor for the use of new concrete in architecture in the early twentieth century with his concrete buildings such as his apartment block at 25 Rue Franklin and the garage on the Rue Ponthieu in Paris. Many more building methods were developed upon the concrete and reinforced concrete while some of them are still applicable today.⁹³

2.2.3. Mass-production and Standardization

Borden explains that the technological improvements and complexity provided more complicated and articulated architectural systems; such as new framing systems, cladding separated from the structure and interior finishing. New material mastery improved construction skills. These improvements by the Industrial Revolution led the mass-production with standardization. While new ways of production such as the

⁹² Concrete: Building Pathology, foreword by David Watt and Peter Swallow, edited by Susan Macdonald. Blackwell Science Ltd., 2003, pg. xiv.

⁹³ Jörg Brandt, Bruno Kauhsen, Friedbert Kind-Barkauskas, Stefan Polonyi. Concrete Construction Manual, translated by Gerd Söffker and Philip Thrift. Basel, Boston and Berlin: Birkhäuser, 2002, pg. 18.

mass-production of steel by the Bessemer furnace emerged and structural properties of the buildings were advanced, essential changes in architecture were emanated regarding form, space, assembly, and production. Crystal Palace by Joseph Paxton for which iterative components were used has been one of the samples of serial production.⁹⁴ Also, as discussed in the previous section of this study and told by Borden, through the mass production of Portland cement and steel, concrete was rediscovered and advanced by reinforcing. He mentions that one of the first cast-in-place concrete buildings was Unity Temple, the Oak Park Universalist Church, which exemplifies the use of serial casting for the repetitive ornament in the columns of the clerestory lighting, by Frank Lloyd Wright.⁹⁵

In the book entitled “Prefabricated Systems: Principles of Construction,” the authors explain the effects of mass-production in architecture with a direct relationship with the automobiles. As mentioned, the promise of Henry Ford about to produce a lower-priced car which would be afforded by an average American was realized with the assembly line, new techniques, and materials.⁹⁶ According to the authors, Le Corbusier was inspired by the mass-production of the automobiles while he regards the house as a machine to live in. Therefore, he designed the “Maison Citrohan” which reflected his dream of the mass production of a house type that would include components produced in factories. Mass production has been considered to have both positive and adverse effects on architecture while the latter includes the ideas about the loss of identity, tradition, crafts and the professionalism of the architect due to standardization led by serial buildings.⁹⁷ As Stanford Anderson says:

⁹⁴ Gail Peter Borden. Process: Material and Representation in Architecture, London and New York: Routledge, 2014, pp. 18-19.

⁹⁵ Ibid.

⁹⁶ Sharon Chung-Klatte, Reinhard Hasselbach, Ulrich Knaack. Prefabricated Systems: Principles of Construction, Basel: Birkhäuser, 2012, pg. 15.

⁹⁷ Ibid., pp.15-16.

“Modern industry ruptured ancient relationships among makers, products, and users: owing to the division of labor, a loss of relation between workers and the objects produced, a correlative standardization of the products, and an increasing emphasis on fashion and obsolescence as stimuli to consumption. The Great Exhibition of 1851 in the Crystal Palace in London assembled the machines and products of modern industry in a prefabricated iron and glass building before a popular audience—building and audience themselves being representatives of the same change in productive means. The event occasioned major reassessments of the condition of culture and society in relation to new productive systems and the environment they produced.”⁹⁸



Figure 2.10 Perspective drawing of “Maison Citrohan,” by Le Corbusier, 1921
Source: Adolf Loos, Le Corbusier. *Raumplan Versus Plan Libre*, edited by Max Risselada. Rotterdam: 010 Publishers, 2008, pg. 74.

2.2.4. Major Influences of the Developments in Industrial Period on Architectural Language and Design

As discussed insofar, with the aid of new materials, scientific, technical and technological improvements in the construction field and new production methods, new means of transportation and building types, such as factories, galleries or railway stations, have been current in architecture since Industrial Revolution. According to Christopher Gildow, as the response to the new industrial landscape of that period, architecture has changed. Before the late 19th century, the strength of the

⁹⁸ Stanford Anderson. *Peter Behrens and a New Architecture for the Twentieth Century*, Cambridge, Massachusetts and London: The MIT Press, pg. 95.

walls supported the weight of a multistory building which means that massively thick walls on the ground floors had to be used to construct taller buildings and still the possible building's height was limited. By replacing wood, brick, and stone with forged iron and milled steel, it became possible to construct larger and taller buildings.⁹⁹

Since the inventions have removed the limitations on buildings' sizes, the general visual texture of the built environment has changed. Gelernter explains that the development of gas lighting system, which eliminates the restriction of the buildings' width by the need for natural light, and rudimentary steam heating, as well as air cooling systems, have enabled buildings to be constructed in any size. The development of iron and steel and cheap production of them have allowed buildings to grow much larger. Because it was easy to produce architectural elements in iron and later steel by hundreds quickly and cheaply, these new materials have led the standardization. The strength of them has reduced the thickness of the architectural forms while it has enabled to construct higher buildings as mentioned before.¹⁰⁰

Although there have been revivals of former architectural styles¹⁰¹ (which will not be discussed in this study) in this period, the main impact of Industrial Revolution has been on the appearance of the Pre-Industrial Period's vernacular architecture which has become an industrial and technological one within the frame of "machine aesthetic"¹⁰² and standardization. To describe the outlook of the built environments in this period, Benevolo quotes the following passage that describes the Coketown in Birmingham which was an industrial town. It shows how buildings have become machine-like and standardized units in this period.

⁹⁹ Christopher Gildow. "Architecture and the Industrial Revolution," Open Course Library, 2012, <https://learn.canvas.net/courses/24/pages/m9-architecture-and-the-industrialrevolution>, (May 24, 2016).

¹⁰⁰ Op. Cit., Gelernter, pg. 154.

¹⁰¹ See Ibid., pp. 157-166.

¹⁰² See Op. Cit., Banham, 1980.

“It was a town of red brick, or of brick that would have been red if the smoke and ashes had allowed it; but as matters stood it was a town of unnatural red and black, like the painted face of a savage. It was a town of machinery and tall chimneys, out of which interminable serpents of smoke trailed themselves forever and ever, and never got uncoiled. It had a black canal in it, and a river that ran purple with ill-smelling dye, and vast piles of building full of windows where there was a rattling and a trembling all day long, and where the piston of the steam engine worked monotonously up and down, like the head of an elephant in a state of melancholy madness. It contained several large streets all very like one another, and many small streets still more like one another, inhabited by people equally like one another, who all went in and out at the same hours, with the same sound upon the same pavements, to do the same work, and to whom every day was the same as yesterday and tomorrow, and every year the counterpart of the last and the next . . . All the public inscriptions in the town were painted alike, in severe characters of black and white. The jail might have been the infirmary, the infirmary might have been the jail, the town-hall might have been either, or both, or anything else, for anything that appeared to the contrary in the graces of their construction; fact, fact, fact everywhere in the material aspect of the town; fact, fact, fact, everywhere in the immaterial. The M'Choackumchild school was all fact, and the school of design was all fact, and the relations between master and man were all fact, and everything was fact between the lying-in hospital and the cemetery, and what you couldn't state in figures, or show to be purchasable in the cheapest market and saleable in the dearest, was not, and never should be, world without end, Amen.”¹⁰³



Figure 2.11 Sketch of built environment in Industrial Period as seen by Pugin

Source: Op. Cit., Benevolo, pg. 130.

¹⁰³ Ibid., pp. 129-130.

2.3. Post-Industrial Period and Material-Related Shifts

Jean Nouvel says that “Each new situation requires a new architecture.”¹⁰⁴ In the post-industrial architectural context, Leonard Bachman’s statements in “Two Spheres: Physical and Strategic Design in Architecture,” can be considered as a supportive explanation for Nouvel’s quotation. For Bachman, because of the situation that architecture should reflect the societal, cultural, and technological changes, Post-Industrial architecture has the significance chance to manifest the radical shifts in these changing contexts.¹⁰⁵

The story of human civilization was described as ‘a co-evolving history of technical progress, industrialization, and social good’ by Scottish ecologist Patrick Geddes and American historian Lewis Mumford. They explained the order of this evolution in three eras titled as “eotechnic,” “paleotechnic,” and “neotechnic”¹⁰⁶ which are referred as Pre-Industrial, Industrial, and Post-Industrial in this study. These periods include alternately, a long time of the main production of raw materials by farming and mining followed by a shorter interval of commodities by industry, and finally the current period of innovation and scientific progress.¹⁰⁷ Harvard sociologist Daniel Bell is another referred figure for Bachman to explain post-industrial architecture. For Bell, post-industrial society has been constituted since the late 1950s when the outcomes of World War II started to be observed in terms of economy and informational subjects.¹⁰⁸

¹⁰⁴ Jean Nouvel as quoted in Dezeen Magazine, <http://www.dezeen.com/2007/04/03/100-11th-avenue-by-jean-nouvel/>, (May 11, 2016).

¹⁰⁵ Op. Cit., Bachman, pg. 6.

¹⁰⁶ Patrick Geddes and Lewis Mumford as cited in *Ibid.*, pg. 3.

¹⁰⁷ *Ibid.*

¹⁰⁸ Daniel Bell as cited in *Ibid.*, pg. 4.

Regarding architecture, post-industrial alteration led the design to become more human-centered and have long-term value. The post-industrial thought started to be reflected in architecture with a whole new range of impressions such as ecology, design programming, systems theory, and the effect of postmodern philosophy. Since then, architectural practice and design thinking have been reshaped.¹⁰⁹ Post-industrial shifts have transformed the production of goods into information-based production by knowledge workers.¹¹⁰ To present a visual analogy about the differences between industrial thought and post-industrial one, Bachman says:

“...mechanistic industrial age efforts are like a tree farm, a machine for making trees. Postindustrial age pursuits are like a forest, a set of robust natural processes. Consider that the tree farm is artificial. It will require ever more fertilizer, insecticide, and maintenance; yet it will produce a continually declining yield of lumber. If struck by lightning it will burn down and disappear. The forest, on the other hand, will replenish itself indefinitely as long as its system and cycles of nutrient flow are left intact. So robust is the forest that should it be struck by lightning and burn down, it will gradually grow back without human intervention into a similar kind of forest. The tree farm is a machine. The forest is a system. Postindustrial society is far less concerned with the machine and the lumber it produces than at any time before in history. We have learned that most of the long-term success models in the universe are systems, and we have learned that using those systemic solutions in our own means of production are the most viable.”¹¹¹

As discussed by Bachman, there have been many factors regarding economical, cultural, societal, and technological shifts that affected the progress toward complexity since Pre-Industrial Period to ongoing Post-Industrial Age. Among these factors; production, material, and architecture related considerations are shown with their differences in different periods while the descriptions of these stages with keywords provided by Daniel Bell are included in Table 2.1.

¹⁰⁹ Ibid.

¹¹⁰ Ibid., pg. 6.

¹¹¹ Ibid., pg. 7.

Table 2.1 Compared considerations of Pre-Industrial Period, Industrial Period and Post-Industrial Period

Source: Rearranged by the author according to the Table 1.1, 1.2, and 1.3 in Ibid., pp. 5-10.

Context to Compare	Pre-Industrial Period	Industrial Period	Post-Industrial Period
Description with keywords ¹¹²	Agriculture and mining for raw materials as the basis of production	-Producing goods by converting raw materials and consuming these products consistently -Hegemony of practical know-how -Essential productive labor	Information as currency, data as empirical reality, knowledge as decision making, stochastic forecasting, codification of theoretical knowledge, primacy of human capital, growth of intellectual technology
Design	Craft and design are regarded as the same	Design as a specialty and profession	Design as a discipline and universal occupation
Profit Yield	Extraction	Fabrication	Analysis
Economic Sector	Agriculture and mining	Manufacture	Services
Transformative Resource	Wind, water, animals	Coal, petroleum, electricity, nuclear energy	Information
Skill	Craft	Know-how	Science and design
Organizations	Private companies	Corporations	Global networks
Materials	Raw materials obtained from nature	Processed material and mass production with standardization	Mass customized components and materials

¹¹² Since Bell uses the same titles for the periods with the ones in this study, the descriptive keywords are borrowed from him. Daniel Bell as cited in Op. Cit., Bachman, pg. 5.

2.3.1. Contemporary Materials

According to Thomas Schröpher, remarkable improvements in the materials have been observed that have provided new possibilities to designers over the past few decades and continuous period. While new materials and advancements, which contribute to the perception of building materials, their use, and environmental impacts, have emerged; traditional materials have been modified such as adding phosphorescent inorganic pigments into concrete to make it aglow at night. The modifications in materials and new technologies are providing ways to construct buildings with higher performance, efficiency, and sustainability. For him, new materials have appeared lately can be categorized under three headings as composite materials which present more significant efficiency, smart materials which ensure greater performance and nanomaterials of which most important feature is to provide greater adaptability.¹¹³

“Composite materials” are described as the modified and innovative versions of traditional materials by Schröpher.¹¹⁴ As explained Blanko Kolarevic, composite materials, of which properties are higher than its components, are created by combining two or more different constituent material components. They are produced by two main components which are the matrix generally including a metallic, ceramic or polymer material; and the reinforcement including fibers obtained from glass, carbon, polyethylene or some other material. Additives such as lightweight fillers or chemical additives could be added to these two components.¹¹⁵

For Kolarevic, plastics are one of the composite materials which have been started to use commonly by architects due to their high formability, relatively low cost and

¹¹³ Thomas Schröpher. Material Design: Informing Architecture by Materiality, Basel: Birkhäuser, 2011, pg. 164.

¹¹⁴ Ibid.

¹¹⁵ Blanko Kolarevic. Architecture in the Digital Age: Design and Manufacturing, revised edition, New York and London: Spon Press, 2004, pg. 81.

high strength-to-weight ratio and minimum maintenance. He explains that in the 1960s and 1970s, they were applied with keen interest because of being able to take any shape. However, with the shifting aesthetics of the late 1970s and early 1980s in addition to their poor weathering capabilities, and the omnipresence of plastic products caused to their second-class status later on.¹¹⁶

“Smart materials” is the second group of materials which are discussed by Schröpher.¹¹⁷ As cited by him, Sheila Kennedy mentions that smart materials are produced by combining chemical or mechanical devices with a material to make them have changeable properties such as shape or color. They can also make changes in density, opacity, dynamic movement, and state of deterioration.¹¹⁸ According to Schröpher, adaptive and changing materials have been used since hundreds of years ago. Therefore, the changes such as chemical ones in the smart materials are relatively conventional and non-revolutionary. However, using this chemical change as a design solution in architecture is new and makes smart materials significant. He adds that some of the applications of smart materials do not necessarily alter the performance of a building, such as the surface-related applications with visual effects like “appearing pattern wallpaper.” On the other hand, some other smart materials such as dye solar cells which generate an electrical current with only a small amount of light provide greater efficiency in buildings and higher sensitivity to lifecycles of products employed in building construction.¹¹⁹

The third group of materials discussed by Schröpher is “nanomaterials.”¹²⁰ According to the U.S. National Science and Technology Council, nanotechnology is “ the research and technology development at the atomic, molecular or

¹¹⁶ Op. Cit., Kolarevic, pg. 82.

¹¹⁷ Op. Cit., Schröpher, pp. 166-168.

¹¹⁸ Sheila Kennedy as cited in Ibid., pp. 166-167.

¹¹⁹ Ibid., pp. 167-168.

¹²⁰ Ibid., pg. 168.

macromolecular levels, in the length scale of approximately 1-100 nanometer range, to provide a fundamental understanding of phenomena and materials at the nanoscale and to create and use structures, devices and systems that have novel properties and functions because of their small and/or intermediate size.”¹²¹

About the effect of nanomaterials in architecture, Schröpher refers Peter Yeadon, who mentions that nanomaterials have a remarkable impact on the human experience of architecture even the adaptability or changeability of them, is almost imperceptible by the average building user.¹²²

In the article entitled “The Promise of Nanomaterials in Architecture,” Hallie Busta tells that nanotechnology is used to advance many applications such as to provide durable materials, resilient and self-cleaning finishes for example coatings with titanium dioxide nanoparticles, wave benders to control elastic waves, more and better graphene, and stronger concrete.¹²³

New materials and technologies started to have effects on building industry in response to altering architectural practice and design thinking led by post-industrial thought. Even there have not been dramatic changes in a material palette of architecture; recent developments in material studies, which are discussed in previous paragraphs, can be considered as the first steps of a remarkable material-related shift in architecture.

¹²¹ American Nanoscale Science, Engineering and Technology Subcommittee of the U.S. National Science and Technology Council as quoted in Sylvia Leydecker. Nano Materials: in Architecture, Interior Architecture and Design, Basel, Boston and Berlin: Birkhäuser, 2008, pg. 12.

¹²² Peter Yeadon as cited in Op. Cit., Schröpher, pp. 167-168.

¹²³ Hallie Busta. “The Promise of Nanomaterials in Architecture,” The Journal of the American Institute of Architects, 2015, online version, http://www.architectmagazine.com/technology/the-promise-of-nanomaterials-in-architecture_o, (June 8, 2016).



Figure 2.11 Structural glass (composite material) stairs in the Danmarks Nationalbank
Source: <http://www.mikkelsengroup.dk/projekt/danmarks-nationalbank-ombygning/>, (May 25, 2016).



Figure 2.12 (left) Decker Yeadon's homeostatic facade system (created with smart materials) which shifts and moves according to outside air's temperature
Source: Chirs Lefteri. "How Do Mysterious Memory Materials Work," ArchDaily, 2014, <http://www.archdaily.com/533679/how-do-mysterious-memory-materials-work>, (May 28, 2016).

Figure 2.13 (right) Cellulose nanocrystals which are used to produce stronger concrete
Source: Op. Cit., Busta.

2.3.2. The Advent of Computer-Aided Design

The advent of computers into the architectural realm has influenced the practice of architecture as mentioned by Yehuda Kalay. The design and construction processes were not separated geographically, and design ideas were studied on papers before the introduction of the digital world. In the early 1970s, architectural practice has started to be penetrated by the computer-aided architectural design systems. By the developments in the computer technology and other types of information works, using database technology and digital storage devices has become a standard method in the architectural design process. Therefore, digital, complex, detailed and three-dimensional models of buildings have been started to be frequently produced. With these improvements, fabrication and construction machines have been enabled to drive digital models which are produced with computer-aided design technology.

Kalay continues explaining that in the 1990s, computer-aided collaboration has been introduced as a result of the globalization of the building industry and the improving capabilities of computers as telecommunication methods. Also, some systems which can process various data formats about the typical construction projects have been presented. As a consequence of these developments, the design process itself has changed as well. Although architectural design solutions are still crafted manually, and architecture has been slower than other disciplines to benefit from information technology¹²⁴, as mentioned by Kolarevic the use of digital media in architectural design to both visualize intentions and to derive architectural form has increased in architecture.¹²⁵

Aside from representation, materiality has been influenced by digital design methods as well. For example, to predict the structural performance of buildings through

¹²⁴ Yehuda E. Kalay. Architecture's New Media: Principles, Theories and Methods of Computer-Aided Design, Cambridge and London: The MIT Press, 2004, pp. ix-xvii.

¹²⁵ Op. Cit., Kolarevic, pg. 17.

controlling materials digitally¹²⁶ as well as to estimate the cost of materials has got easier.¹²⁷ Also, it has become possible digitally to produce the geometric model of the objects with surface details by applying a material on it digitally. The designer has been enabled to test different materials on his model before deciding on the one to be implemented in the construction.¹²⁸ Additionally, computer-aided design has provided the opportunity of producing scale models which can be made from materials that stimulate the actual ones to be used in the building. Therefore, it has become easier to test the design ideas in the real stage.¹²⁹ About the digital production Sebastien Delanrange says:

“New materials and digital production methods revolutionize the world of contemporary architecture. Innovative material applications and production methods do not only lead to the constructability of a new formal language: they provide designers the unique opportunity to challenge construction standards and to directly communicate with production facilities. The resulting production of custom made building components allows for a realization of structures with unprecedented complexity that can respond to the current demands and goals in the architecture discipline.”¹³⁰

According to Kalay, computer-aided design can only help architectural design effectively if its successes, as well as the failures of information technology, can be comprehended. If the designers can achieve this, it is possible for them to take advantages of it such as “mass-customization.”¹³¹

¹²⁶ Op. Cit., Kalay, pg. 64.

¹²⁷ Ibid., pg. x.

¹²⁸ Ibid., pg. 174.

¹²⁹ Ibid., pg. 125.

¹³⁰ Sebastien Delanrange as quoted in Kathrin M. Wiertelarz. Processes of Making: Algorithmic Methods in Architectural Practice, Kassel: Kassel University Press, 2016, pg. 76.

¹³¹ See Ibid.

2.3.3. Mass-Customization

According to Blanko Kolarevic, because of the difficulties about the constructability of new formal complexities, the designers had limited choices in architectural forms. On the other hand, the use of digital information enabled the designer to have more control and individuality on the designs¹³² that would lead the idea of ‘variation’ in building industry and the notion of ‘mass-customization’ which will be explained below.

As discussed in the Industrial Period context, industrial manufacturing with standardization by mass-production has been the dominant factor that has directed the building production and materials. This situation started to be changed in Post-Industrial Period. According to Joseph Pine II, there is a ‘new frontier in business competition’ which is titled as ‘mass-customization’ whose terrain is different from that of mass-production.¹³³ As cited by Kolarevic, Pine describes mass-customization as the mass production of customized goods and services according to individual wants. It provides variation and customization without price-rise.¹³⁴ Pine says:

“In this new frontier, a wealth of variety and customization is available to consumers and businesses through the flexibility and responsiveness of companies practicing this new system of management. In the past twenty years, the number of different items on supermarket and pharmacy shelves has exploded, allowing manufacturers and retailers to reach ever-finer granularities of consumer desires. You used to go to a fast-food restaurant for a mass-produced cheeseburger, french fries, and a shake; now the same restaurant provides a half dozen varieties of burgers along with chicken sandwiches, salads, pizza, fajitas, burritos, submarine sandwiches, spaghetti, carrot and celery sticks, bottled mineral water—you name it and it is standard fare today, being test-marketed, or under development.”¹³⁵

¹³² Op. Cit., Kolarevic, pg. 88.

¹³³ See, B. Joseph Pine II. Mass Customization: The New Frontier in Business Competition, Boston, Massachusetts: Harvard Business School Press, 1993, pp. 3-8.

¹³⁴ Ibid., pp. 6-7, as quoted in Op. Cit., Kolarevic, pg. 84.

¹³⁵ Op. Cit., Pine II, pg. 7.

Architecturally speaking, Kolarevic explains that while industrial manufacturing imposed simple geometric forms over complex ones and the repetitive use of low-cost components by mass-production, digitally-controlled machinery enabled to fabricate unique parts with complex shapes. Also, these individual components are allowed to be produced inexpensively. Therefore, variation in building production and the notion of ‘mass-customization’ were introduced into building design and production.¹³⁶

Kolarevic says that mass-customization has influenced almost every section of the production which includes clothing, electronic or mechanical devices. On the other hand, the building industry has not been affected yet as much as other segments of the economy have been from mass-customization¹³⁷ The first reason of this situation is already mentioned as the constructability. The second cause of this can be considered as the claim to produce buildings with low-cost. Dan Willis and Todd Woodward say that using standard products and components in the construction industry has become commonly approved design mandatory because of economical reasons. Using customized products causes remarkable increases in cost.¹³⁸

The context of sustainability can be considered to include other reasons not to favor mass-customization in architecture. While explaining contributions of mass-customization to architecture, T. D. Bruno, K. Nielsen, S. B. Taps and K. A. Jorgensen also mention the drawbacks which can refer these other reasons. They explain that since to use more material resources for mass-customized production compared to mass-production could be expected; greater environmental influence would be observed. Also, energy consumption would be more in mass-customization

¹³⁶ Op. Cit., Kolarevic, pg. 84.

¹³⁷ Ibid., pg. 85.

¹³⁸ Dan Willis and Todd Woodward. “Diminishing Difficulty: Mass Customization and the Digital Production of Architecture,” Fabricating Architecture: Selected Readings in Digital Design and Manufacturing, edited by Robert Corser. New York: Princeton Architectural Press, 2012, pg. 175.

since more different manufacturing processes are required. To distribute each product would necessitate more packaging and probably more energy.¹³⁹

Although there are arguments about the disadvantages of mass-customization in architecture as discussed in the previous paragraph, for Kolarevic, mass-customization is convenient dealing with the building industry because of that the buildings are one-off and peculiarly designed products. For him, with the help of digitally-driven production processes, “customization” methods will be employed commonly in building industry eventually. He mentions that mass-customization enables to produce individual components such as specially shaped and sized structural elements or variable window shapes and sizes, which would provide an optimal variance for making buildings suitable and efficient for different local conditions, or even houses (see Figure 2.14).¹⁴⁰

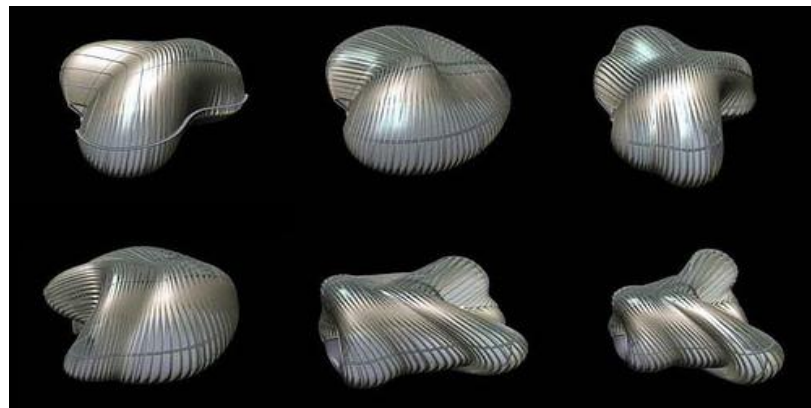


Figure 2.14 Greg Lynn, digitally produced embryological housing variations

Source: <http://iaac-readings.wikidot.com/words:prototopo>, (May 27, 2016).

¹³⁹ Thomas Ditlev Bruno, Kaj A. Jorgensen, Kjeld Nielsen, Stig Brink Taps. “Sustainability Evaluation of Mass Customization,” Advances in Production Management Systems: Sustainable Production and Service Supply Chains, Part I, edited by Dimitris Kiritsis, Vittal Prabhu, Marco Taisch. London and New York: Springer, 2013, pg. 177.

¹⁴⁰ Op. Cit., Kolarevic, pg. 85.

2.3.4. Major Influences of the Developments in Post-Industrial Period on Architectural Language and Design

“Nevertheless, one can discern the beginnings of a shift in architecture that relates to a deep transformation going on in the sciences and in time, I believe, this will permeate all other areas of life. The new sciences of complexity – fractals, non-linear dynamics, the new cosmology, self-organising systems – have brought about a change in perspective. We have moved from a mechanistic view of the universe to one that is self-organising at all levels, from the atom to the galaxy. Illuminated by the computer, this new world view is paralleled by changes now occurring in architecture.”¹⁴¹

Post-industrial thought and the developments, as mentioned in the quotation above from Charles Jencks, have influenced architectural language and design in this period as discussed insofar. Although the built environment of the Post-Industrial Period still resembles the one of the Industrial Period as a result of mass-production and standardization, it has also started to become provoking since there have been building forms which “varies from ungainly blobs to elegant waveforms, from jagged fractals to impersonal datascares,” according to Jencks. He explains that although the incessant repetition of colonnades and curtain walls have been current since the Industrial Period, the idea that to design building forms which are closer to the ever-varying patterns of nature through combinations of architectural styles has emerged as a result of increasing pluralism of global cities. He entitles this new architectural approach as the “Organi-Tech,” which considers technology and structural expression in combination with the ecological issues¹⁴² that will be discussed further in the fourth chapter. However, “Organi-Tech” has not been applied just so in Post-Industrial architecture hence repetitive prefabricated elements, which are identical, have been still in use in the buildings.¹⁴³

¹⁴¹ Charles Jencks. “The New Paradigm in Architecture,” online version of the article, pg. 155, <http://archnet.org/system/publications/contents/4756/original/DPC1453.pdf?1384786587>, (August 10, 2016).

¹⁴² Ibid., pp. 155-156.

¹⁴³ Ibid.

As mentioned by Christopher Day, because of the marketed industrial components used in buildings, it has become harder to realize the difference among factories, hospitals, schools, offices and as such. He says that “the selfless ordinary has become the place-less, ubiquitous bungalow.” The uniformity of manufactured products has eroded the individual choices of the architects.¹⁴⁴ The reasons for the limitations in architectural preferences which are explained by Jencks include the continual decline of the Christian and Modern belief systems and, especially the rise of consumer society and a celebrity system. He explains that an architect is obliged to design an extraordinary landmark as a result of the market economy. While it should be entirely different from anything seen before, it must not refer to any known religion, ideology or set of conventions. Therefore, the architectural decisions have been pushed and pulled in opposite ways. This situation has caused the production of ‘enigmatic’ projects as exemplified by Jencks with the works of Frank Gehry.¹⁴⁵ For Jencks, to design buildings that amaze and delight but are not specific to any ideology, architects now strive to find through a process of search and invention with the aid of the computer new ways to produce landmarks for the sake of market economy. He says “I believe it is the job of architects to take responsibility for the public and esoteric meanings of a civic building, whether enigmatic or not, but this is an especially difficult task in a global culture without a shared value system.”¹⁴⁶

Consequently, it can be said that the ongoing developments in this period are still transforming the built environment through architectural language and building tectonics. However, the considerations of the consumerist society, which will be noted further in the fourth chapter, seem as the impediments on the preferences of the architects. Before discussing these considerations, it is worthwhile to look at how building tectonics have been influenced by the developments in Post-Industrial Period including the material-related changes.

¹⁴⁴ Christopher Day. Spirit and Place, Oxford: Architectural Press, 2002, pp. 12-13.

¹⁴⁵ Op. Cit., Jencks, pg. 158, also see 3.3.3. in this study as an example to Gehry’s projects.

¹⁴⁶ Ibid., pg. 160.

CHAPTER 3

THE TRANSFORMATIVE POWERS OF MATERIAL USAGE IN RELATION TO THE LIMITS OF TECTONICS IN ARCHITECTURE

As discussed in the previous chapter, material usage has been evolved through the ages which have led the remarkable improvements in the architectural 'tectonic' as well. Thus, it is essential to discuss the meaning of the tectonic while explaining the relationship between material usage and tectonics in architecture.

In "*Rappel à L'ordre: The Case for the Tectonic*," Kenneth Frampton explains that 'tectonic' is described as 'to be related to building or construction commonly, especially in architecture and the related arts' in the dictionary. The term *tectonic* derives from the *tekton*, which is Greek, and it refers to the carpenter or builder and therefore it is related to construction. On the other hand, in Sappho, the term *tekton* appears as the role of the poet. For Frampton, the meaning of the term passes to an aspect of poetry from something particular and physical such as carpentry. Therefore, he regards the definition given by the dictionary as a little reductive.¹⁴⁷ According to Frampton, tectonic should be considered as the structural component with its presence that creates formal amplification.¹⁴⁸ He refers to the writings of Karl Bötticher and Gottfried Semper, who tell that 'tectonic' means both structural and material integrity, and poetics of construction that can be applied in architecture and related arts.¹⁴⁹

¹⁴⁷ Op. Cit., Frampton, pp. 93-95.

¹⁴⁸ Ibid., pg. 93.

¹⁴⁹ Karl Bötticher and Gottfried Semper as cited in Ibid.

Frampton adds that tectonics in architecture can be classified in two headings which are “ontological” tectonic and “representational” tectonic. While the first one means a constructional part of which static role and cultural status are emphasized, the second one comprises the representation of the constructional part which is present but hidden. In either case, constructional elements whether they are hidden or not should be considered with the “spiritual value residing in the ‘thingness’ of the constructed object.”¹⁵⁰ According to C. Bundgaard:

“We build in accordance with specific contemporary conditions, defined by production methods, construction and in materials as well as ethics, meaning and values. Exactly this relationship between the work as such and the conditions behind its coming into being is a crucial point. The simultaneity of both material aspects and cultural dimensions is an important condition behind conceiving and constructing architecture. Architecture is something built and it is built somewhere, and these two facts give it its architectural and cultural significance. The concept of 'tectonics' grasps this duality in architecture.”¹⁵¹

In this manner, the evolution of tectonic in architecture should be considered in related with both the structural improvements and changing meanings of formal expressions of architecture. According to Jale N. Erzen, tectonic can be described as the balance between the constructional elements that presents different meanings and references about the universe such as human body standing against the gravity. She adds that throughout the history, tectonic has evolved concerning new constructional methods, new technologies and scientific developments and this evolution can be observed in the transformation of the structural systems as it is seen in the change from linear columns and beams of Greek architecture into the arches of Roman architecture. The Roman arches led the development of dome afterward. As told by her, with the use of new information about the structural systems and materials, it became possible to construct higher and transparent structures, which is exemplified with the Eiffel Tower as one of the pioneering structures representing the evolution

¹⁵⁰ Ibid., pp. 94-95.

¹⁵¹ Charlotte Bundgaard. “Tectonics of Montage: Architectural Positions for a Tectonic Sustainable Building Practice,” Structures and Architecture: Concepts, Applications and Challenges, edited by Paulo J. S. Cruz. London: Taylor & Francis Group, 2013, pg. 391.

of tectonic in architecture.¹⁵² Aside from its new structural system and materials that made it the tallest structure of its time, Eiffel Tower is also considered as the “touchstone of the Modernity” as a consequence of Industrial Age by Banham.¹⁵³

Although the notion of tectonic has evolved with the consequences of Industrial Age, modernity has also caused the current tendency “to reduce architecture to scenography” as explained by Frampton. He says that with the effects of modern architecture, designers have started to regard scenographic approach as an advantageous method since it has provided freedom to the design of the surface and designers have been allowed to create two-dimensional images through a building’s facade.¹⁵⁴ However, as mentioned by Le Corbusier, architecture should be considered about volume and plan as well as the surface.¹⁵⁵

For Frampton, as cited by Juliet Rufford, “architecture's defining characteristics are its materiality, its relationship to topography and corporeality, and the charged relationship that should exist between the formal, structural and symbolic aspects of the work”.¹⁵⁶ While explaining the relationship between tectonics and materials, Frampton refers again Semper, who classifies tectonics according to material procedures as the tectonics of the frame and the stereotomic of compressive mass.¹⁵⁷ Frampton regards these two as ‘light and dark’, ‘immaterial and material’ and ‘sky and earth’ while the last one gives a reference to cosmology to describe the transition between polarities. For him, these kinds of transcultural values and transitions constitute the essence of architecture, and it shows the significance of tectonics and

¹⁵² Jale N. Erzen. *Üç Habitus: Yeryüzü, Kent, Yapı*, Yapı Kredi Yayınları, 2015, pp. 204-205.

¹⁵³ Op. Cit., Banham, 1980, pg. 251.

¹⁵⁴ Op. Cit., Frampton, pp. 90- 94.

¹⁵⁵ Le Corbusier as cited in Ibid., pg. 93.

¹⁵⁶ Kenneth Frampton as cited in Juliet Rufford. *Theatre and Architecture*, London: Palgrave Macmillan, 2015, pg. 17.

¹⁵⁷ Gottfried Semper as cited in Op. Cit., Frampton, pg. 95.

their meanings.¹⁵⁸ In similar with Frampton, Erzen mentions that the balance between the constructional elements and therefore tectonic constitutes the substantial essence of the architecture.¹⁵⁹ In this regard, it can be said that the autochthonous mission of materials to create the tectonics is to form its presence. As expressed by Erwin Viray: “Phenomena exist in the material world. Material makes thoughts tangible. Materials manifest the world.”¹⁶⁰

At this point, to visualize the necessity of the materials to form the tectonic, the explanation for the metaphor of the production process of the clay pot by Andrea Deplazes in his book entitled “Constructing Architecture: Materials, Processes, Structures; a Handbook” can be beneficial. He describes that the pot is produced by reshaping the mass of clay into a hollow space by applying force from outside with one hand and from inside with the other one. These forces supply or at least influence each other and, similarly, the design process in architecture as such is based on the same flow of the events. The design process “advances from both directions: from outside in a standard way from the urbane to the architectural project, and from inside using the spatial and constructional fabric, the tectonics – and both lead from the abstract to the concrete.” Architecture is the boundary and transition zone between the inside and the outside while it unites all architectural, cultural and atmospheric factors in itself. He considers the architects as metaphysicists who would not exist without the physicists. Therefore, how things are done in terms of the structural composition of the substances and building materials used influences and determines the character of architectural space.¹⁶¹ Consequently, it can be said that materials are the components which provide the presence of the built forms by composing their structures and also bring the architectural ideas into being substantial physical forms which are the buildings and architectural products.

¹⁵⁸ Ibid.

¹⁵⁹ Op. Cit., Erzen, pg. 204.

¹⁶⁰ Erwin Viray, “Why Material Design,” foreword to Op. Cit., Schröpher, pg. 8.

¹⁶¹ Constructing Architecture: Materials, Processes, Structures; a Handbook, edited by Andrea Deplazes. Basel, Boston and Berlin: Birkhäuser, 2005, pg.19.

Briefly, it is not possible to produce the pot without the clay as so it is out of the question to construct the structures and buildings without materials. As Borden says:

“Material is the beginning and the end of architecture. It is the tangible that executes the intangible. It is the means of implementation and the means of expression. Materials are the palette from which architecture is made. The use of materials and the associated technologies of construction determine the form and articulation of buildings. The available material resources and the craft of their joinery define the history of architecture.”¹⁶²

For him, material is the medium between the architect and the built form. A designer can be able to use materials effectively by obtaining the vocabulary of materials. The components of architecture as form, structure, sustainability, and geometry, and therefore the tectonics, are dependent on materials. Through understanding the visual and emotional features that materials have, it is possible to produce an ‘aura,’ which means the emotive and experiential association of the materials, and a ‘narrative,’ which represents the story of its history, fabrication, and application. For him, the materials should be at the root of architectural design.¹⁶³

Similarly, Thomas Schröpher mentions that all the features that the architects try to convey by their expressions in built form and the end product that will be used by the people are both developed and restricted by the material aspects that the design employs. The new understandings of the part to whole relationships, organizational configurations, and phenomenological effects can be enhanced by a detailed understanding and studies of materials which includes details from the urban context leading a contemporary knowledge of the built environment with regard to its constituents and the fabric into which they are inserted.¹⁶⁴

¹⁶² Op. Cit., Borden, 2010, pg.8.

¹⁶³ Ibid., pp. 7-8.

¹⁶⁴ Op. Cit., Schröpher, pg. 10.

3.1. Direct Influence of Materials on the Building Tectonics

“Clearly, space, composition and aesthetics are essential in architecture. Materials are not only chosen for technically meeting technological demands. Other factors, like the atmosphere a material creates, play an important role. Some architects let themselves get inspired by materials, with its specific characteristic properties.”¹⁶⁵

As mentioned in the quotation above, aside being an assistant element in the architectural design, the material can originate the whole architectural project. For Schröpfer, Louis Kahn with his use of brick is an example of material inspired designer. He explains that the scale-less examination of materials’ physical and conceptual qualities results in a sophisticated understanding of materials’ use within a broader design concept. Instead of the clichéd and traditional use of materials, it is possible to advance the design with a potential expression and personality of a material by hands-on experimentation and research into their physical and chemical features.¹⁶⁶ Kahn says:

“When you are designing in brick, you must ask brick what it wants or what it can do. Brick will say; I like an arch. You say, but arches are difficult to make, they cost more money. I think you could use concrete across your opening equally well. But the brick says, I know you're right, but if you ask me what I like, I like an arch.”¹⁶⁷

As Schröpfer mentions, the most expressive material application can spur a design concept. In other words, “a material investigation can inspire and enhance an architectural concept.”¹⁶⁸ For him, Kahn’s expression demonstrates his lifelong investigations about the character and potential expressiveness of brick. His use of

¹⁶⁵ Elise van Dooren and Taco van Iersel. “A House of Cardboard,” Cardboard in Architecture, Vol. 7, edited by Mick Eekhout, Fons Verheijen, Ronald Visser. Netherlands: IOS Press, 2008, pg. 88.

¹⁶⁶ Op. Cit., Schröpfer, pg. 25.

¹⁶⁷ Louis Kahn. "Space and Inspirations," Louis I. Kahn, Writings, Lectures, Interviews, edited by Alessandra Latour. Newyork: Rizzoli, 1991, pg. 228, as quoted in Ibid.

¹⁶⁸ Ibid., pg. 20.

brick is different than the other masters of the material, such as Wright and Aalto. Even these three architects would work the material physically; they would reflect a different attitude about the brick's character and potential. Therefore, brick informed their design concepts in various ways.¹⁶⁹ For Andrew Pressman, Kahn's famous quotation above expresses honest or essential use of materials in a building. For him, observing concrete in compression and steel in tension is sufficient, while using plastic looking like stone or stucco is not. To select a material and designing according to its features as well as to apply it in a building and to detail it for a particular project requires comprehending the spirit of the material involving limitations and visual possibilities. By understanding material's specific properties, it is possible to design a building that features the material.¹⁷⁰ It should be comprehended that materials can be and have been the basis of building tectonics.

Although to emphasize or subdue the properties of material depend on architectural intentions as mentioned by Pressman¹⁷¹, Lorraine Farrelly states that 'true' architecture necessitates the honest use of materials. For her, a building with a brick wall supporting a roof is a product of 'true' architecture due to honestly used materials. The idea of 'truth' to materials requires using materials in their most effective ways according to their properties. Although it is not an obligation to reveal the building's structure, concealing the structure of the building such as using brick wall in a steel-framed building is not surely 'true' in terms of using materials.¹⁷²

The reason for that architects have started to use materials in a dishonest way can be regarded as the influence of market economy in architecture. Gelernter explains that in the Industrial Period, architects have started to use new material, which was iron, as an economical alternative for the traditional materials. He exemplifies this with

¹⁶⁹ Ibid.

¹⁷⁰ Andrew Pressman. Designing Architecture: The Elements of Process, New York: Routledge, 2012, pg. 80.

¹⁷¹ Op. Cit., Pressman.

¹⁷² Op. Cit., Farrelly, pg. 5.

the painted cast iron plates covering, which resemble stone, on the face of a bank in Pottsville by John Haviland, Thomas Ustick Walter's Capitol building dome built with cast iron which mimics wood and stone, and as such. Ironworkers and foundries offered ways to cast entire facades that look like traditional materials.¹⁷³ Therefore, the inherent values of materials that give the idea about their region, history or culture have been ignored hence they have been replaced with the imitations. This situation has caused to consider materials as if they are wall painting that is applied after the construction of the wall. However, as mentioned by Achim Menges, the innate behavior, characteristics and capacities of the materials should be accounted for the very physicality of architecture, in other words, the building tectonics, not just for the appearance.¹⁷⁴ As Manuel DeLanda says:

“In one philosophy one thinks of form or design as primarily conceptual or cerebral, something to be generated as a pure thought in isolation from the messy world of matter and energy. Once conceived, a design can be given a physical form by simply imposing it on a material substratum, which is taken to be homogeneous, obedient and receptive to the wishes of the designer.... The opposite stance may be represented by a philosophy of design in which materials are not inert receptacles for a cerebral form imposed from the outside, but active participants in the genesis of form. This implies the existence of heterogeneous materials, with variable properties and idiosyncrasies which the designer must respect and make an integral part of the design which, it follows, cannot be routinized.”¹⁷⁵

In the following case studies, which are aimed to present the direct relation between different materials and different building tectonics, from 20th and 21st centuries, the importance of materiality as the basis of architectural design will be exemplified to demonstrate the significance of the association between the materials and tectonics.

¹⁷³ Op. Cit., Gelernter, pg. 154.

¹⁷⁴ Although Menges mentions his ideas about materiality within the frame of computational design, the statements of him are regarded valid for every kind of architectural design in this study. Achim Menges. “Material Resourcefulness: Activating Material Information in Computational Design,” Material Computation: Higher Integration in Morphogenetic Design, edited by Achim Menges. John Wiley & Sons, 2012, pg. 36.

¹⁷⁵ Manuel DeLanda as quoted by Ibid.

3.1.1. Chapel of Notre Dame du Haut, Ronchamp by Le Corbusier, 1954

As explained by Nicole Bridge, the sculptural qualities of concrete were utilized by Le Corbusier in this chapel which is different than from his earlier works.¹⁷⁶ Regarding this difference, Andrew Kroll clarifies that Ronchamp, which includes two entrances, an altar, and three chapels, is designed in a more irregular sculptural form while Corbusier's other projects were designed in boxy, functional, and sterile volumes. He notes that the sculptural character of the building is provided by the walls of Ronchamp, which constitute the structure of the building while supporting the massive curvilinear roof as well. These structural and sculptural walls are also used as acoustic amplifiers. For example, the sound is reflected out over the field from the outdoor altar by the eastern exterior wall.¹⁷⁷

According to Kroll, white painted concrete walls of the Ronchamp and light which enters into the chapel create an ethereal atmosphere that corresponds with the religious activities. For him, the curved roof which appears to float above the building is the most intriguing part of the building. The gap between the walls and the curved roof, which seems weightless due to its curves of an airplane wing, lets the clerestory light in. He also regards the sporadic window placement on the walls, which creates a speckled pattern through the light that enters from openings, as interesting. He enunciates that, the chapel is defined formally with the curving walls and roof from outside as a sculpture while the light defines and gives meaning to it conceptually.¹⁷⁸

With its resemblance to a handcraft product of a sculpturer that is unique and created by touching the material, Notre Dame du Haut Chapel also seems as an inherited part of the natural environment with the aid of the simplicity of the concrete's surface and

¹⁷⁶ Nicole Bridge. Architecture 101: From Frank Gehry to Ziggurats, an Essential Guide to Building Styles and Materials, Adams Media, 2015, pg. 211.

¹⁷⁷ Andrew Kroll. "AD Classics: Ronchamp/ Le Corbusier," ArchDaily, 2010, <http://www.archdaily.com/84988/ad-classics-ronchamp-le-corbusier>, (July 22, 2016).

¹⁷⁸ Ibid.

curved formwork. Also, the smooth surface of the concrete with the well-matched use of light and shadows that create a religious atmosphere shows how Corbusier appreciated the textural qualities of concrete.



Figure 3.1 Sculptural view of the Notre Dame du Haut Chapel in Ronchamp
Source: Ibid.



Figure 3.2 Use of light on the smooth concrete walls of the Notre Dame du Haut Chapel in Ronchamp
Source: Ibid.

3.1.2. Cathedral of Brasilia by Oscar Niemeyer, 1970

Sixteen parabolic columns that reach out skyward constitute the structure of Brazilian Cathedral which was designed by Oscar Niemeyer, who is one of the concrete masters as mentioned by Eric Baldwin. They are combined with different shades of blue, white and brown stained glass windows.¹⁷⁹ While John Malam regards the building's form as a crown that represents the crown of thorns worn by Christ¹⁸⁰, Megan Sveiven regards the columns as two hands which reach up towards the sky.¹⁸¹

Building's circular plan, which changes the hierarchies of spatial division of the traditional church plans, makes the sacred, and the profane joined on the same plane. Also, while the spaces of traditional churches are dark, this church's space for divine worship, which is reached through a thin and dark tunnel, is full of light and happiness. Megan Sveiven mentions that stained-glass window is used to make the physical sky seeable without any mediation, and heavens are represented through these windows. However, the Cathedral's structure remained open for many years till 1970 when the transparent glass was used to enclose the ceiling. The curved elements were painted white and stained-glass windows were installed in the 1980s.¹⁸²

In similar with the Ronchamp, the sculptural and structural qualities of concrete give this cathedral its architectural identity through its parabolic concrete columns which

¹⁷⁹Eric Baldwin. "Material Inspiration: 10 Projects Inspired by Concrete," *ArchDaily*, 2013, <http://www.archdaily.com/457418/material-inspiration-10-projects-inspired-by-concrete>, (July 23, 2016).

¹⁸⁰ John Malam. *Super Structures*, USA: Franklin Watts Grolier Publishing Co., Inc., 2000, pg. 21.

¹⁸¹ Megan Sveiven. "AD Classics: Cathedral of Brasilia / Oscar Niemeyer," *ArchDaily*, 2011, <http://www.archdaily.com/101516/ad-classics-cathedral-of-brasil-osc-osc-niemeyer>, (July 23, 2016).

¹⁸² Lauro Cavalcanti. *When Brazil was Modern: Guide to Architecture 1928-1960*, Princeton Architectural Press, 2003, pg. 382.

also present the religious value of the building. It appears as this building reaches to the sky by gaining strength from the flat and solid ground which exemplifies the transitional meanings in building tectonics. Also, the bronze sculptures next to the building appear as the protectors of the crown-shaped building which offers a compositional and spiritual story about the building.



Figure 3.3 Crown-shaped form of the Cathedral of Brasilia with the four bronze sculptures next to the building

Source: Op. Cit., Sveiven.

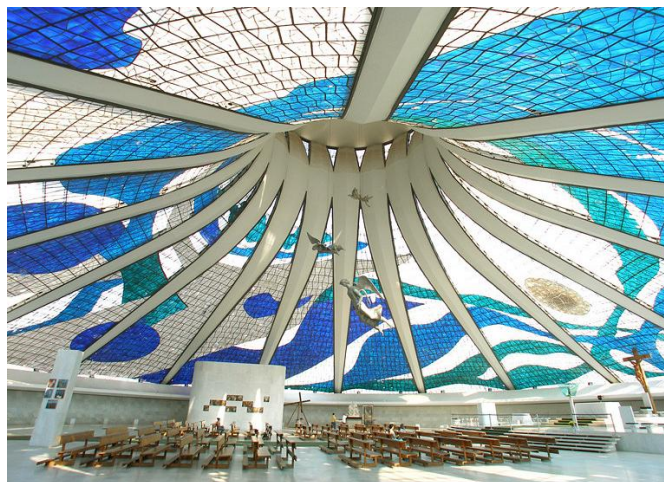


Figure 3.4 Cathedral of Brasilia's colored-glass roof that makes interior fully illuminated

Source: Ibid.

3.1.3. Indian Institute of Management Building by Louis Kahn, 1974

For Schröpher, Louis Kahn, who is well-known with his use of brick, wanted to connect three various scaled programs which are institutional classrooms, faculty housing, and student dormitories by the existing different sized components by load-bearing brick walls with concrete floor slabs. By exploring brick structurally, he created a uniform material language across the campus. India's seismically active environment was reflected with the reverse arches in brick while Kahn also used them as a historical reference back to the Roman brick construction techniques.¹⁸³

Klaus-Peter Gast explains that tradition and modernity, as well as the western and the eastern mentalities, were combined with Kahn's established language of archaic, unfinished brick building mass with perceivable concrete piers in this building. Kahn celebrates the brick, which is India's simplest and cheapest building material, by using it carefully proportioned with the most proper geometry. The rigid and complex geometry of the building is used to refer transcendent forms of appearance in Indian thought.¹⁸⁴ As mentioned by Andrew Kroll, "it was Kahn's method of blending modern architecture and Indian tradition into an architecture that could only be applied for the Indian Institute of Management."¹⁸⁵

Since brick has been a local building material in India, and a traditional material to construct arches in architectural history because of its structural features, the way of Louis Kahn applied brick by using these features while also providing a relation between the building and the region shows how Kahn appreciated the material's potential to inspire a project with the architectural spirit.

¹⁸³ Robert McCarter. Louis I. Kahn, London and New York: Phaidon, 2005, pp. 250-251, as quoted in Op. Cit., Schröpher, pg. 26.

¹⁸⁴ Klaus-Peter Gast. Louis I. Kahn, translated by Susanne Schindler. Basel, Berlin and Boston: Birkhäuser Verlag, 1999, pg. 94.

¹⁸⁵ Andrew Kroll. "AD Classics: Indian Institute of Management / Louis Kahn," ArchDaily, 2010, <http://www.archdaily.com/83697/ad-classics-indian-institute-of-management-louis-kahn>, (July 10, 2016).



Figure 3.5 General view of Indian Institute of Management Building
Source: Ibid.



Figure 3.6 Brick arch of Indian Institute of Management Building
Source: Ibid.

3.1.4. Thorncrown Chapel by E. Fay Jones, 1980

Thorncrown Chapel, which is designed by E. Fay Jones, is located in the forests amongst the oaks, pines, and maples as noted by Andrew Galloway. The area where the chapel would be located was bought by Jim Reed to construct a retirement cabin on it. But, As a result of tourist attraction to the site, Reed decided to have a non-denominational chapel built. Therefore, a simple and remarkable structure which Jones describes as a "place to think your best thoughts" that is appreciated by everyone was constructed. This building has been called the best American building since 1980.¹⁸⁶

In addition to the simplicity of the building, the use of materials which are glass and wood obtained from local pine trees is remarkable as well. Through repeated columns and truss structure which are covered with over 425 glass windows, the vertical chapel appears as a "forest within a forest." While high amount of light spill through a central skylight to the interior of the chapel at daytime, custom lanterns on the columns, which appear as if they were lit somewhere off in the forest, are used to illuminate inside the building at night.¹⁸⁷

As a remarkable example of the direct influence of the materials on building tectonics, this building clearly presents the transition between the tectonics of the frame and the stereotomic of compressive mass which gives a clear reference to cosmology through Frampton's 'sky and earth' couple as discussed before. While it is rooted on the bare earth in the forest, the timber elements of the structure extend upward to the sky as the branches of the trees. Therefore, the wooden structure establishes a strong bond between the region and the building while it also creates a spiritual atmosphere that is convenient for the building program.

¹⁸⁶ Andrew Galloway. "AD Classics: Thorncrown Chapel / E. Fay Jones," *ArchDaily*, 2014, <http://www.archdaily.com/533664/ad-classics-thorncrown-chapel-e-fay-jones>, (July 15, 2016).

¹⁸⁷ *Ibid.*



Figure 3.7 Thorncrown Chapel like a “forest within a forest”
Source: Ibid.

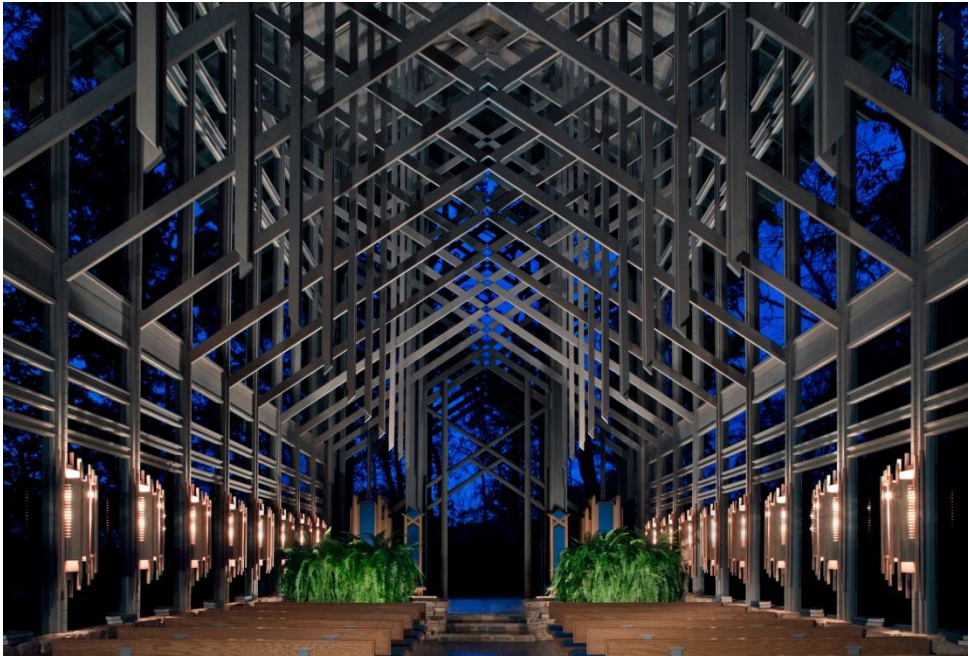


Figure 3.8 Interior view of the Thorncrown Chapel
Source: Ibid.

3.1.5. Vitra fire station by Zaha Hadid Architects, 1993

Zaha Hadid's first recognized project of her career, the Vitra fire station, which was completed in 1993, constitutes a linkage between the artificiality of the existing Vitra design campus, and the surrounding landscape as noted by Kroll. The narrow profile of the building makes it appear as the landscape's extension, or extrusion. The composition of concrete planes which tilt, break, and bend based on the conceptual connection of landscape and architecture that constitutes abstract dynamic forces. The formal aesthetic of the building is created through a state of tension which triggers a sense of instability. Horizontal planes, which slip over one another while another is protruded on the garage bay, bolster the sense of instability. A dense and opaque quality, which limits views into the building, is formed by the concrete planes.¹⁸⁸

Kroll adds that the formal and spatial complexity of the fire station's exterior is observable at the interior of the building as well. According to the building program, planes slide past one another. The layered walls define the spaces of the program between them by bending, tilting, and being broken. Both inside and outside of the building, sense of indirect instability, as well as some semblance of stability, is created.¹⁸⁹ About the frozen motion of the building, Gevork Hartoonian says:

“The exit door canopy, the most theatrical element of the project, is cut in analogy to a broken wing that wants to take the building off the ground. The image is held in place by 12 pipe-columns, a few in vertical positions, the rest inclined. In addition to these features, which promote the perception of lightness, other detailing strategies providing lightness concern the metal screen grilles, and the shape of the window cuts. These, and the cuts implemented in the massing of the Vitra, reveal tectonic figuration that concerns movement and theatricality.”¹⁹⁰

¹⁸⁸ Andrew Kroll. “AD Classics: Vitra Fire Station / Zaha Hadid Architects,” *ArchDaily*, 2011, <http://www.archdaily.com/112681/ad-classics-vitra-fire-station-zaha-hadid>, (June 27, 2016).

¹⁸⁹ *Ibid.*

¹⁹⁰ Gevork Hartoonian in *Op. Cit.*, Löscke ed., pg. 68.

The expressive qualities of concrete such as texture and structural features that enable to construct structural planes are combined with the poetics of the construction in this building which evokes an idea of fire-related movement. Bending, tilting and breaking planes in addition to the door canopy that reaches to the sky make this building appears as if it goes towards the fresh air to avoid fire. In other words, this fire station tells a contextual story through its structural elements.



Figure 3.9 Exit door canopy of the Vitra fire station

Source: Op. Cit., Kroll. “AD Classics: Vitra Fire Station / Zaha Hadid Architects.”

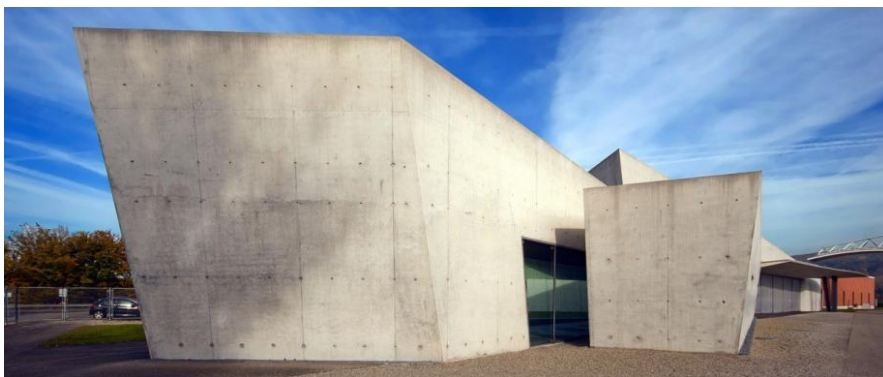


Figure 3.10 Concrete walls, which bend, tilt, and break, of Vitra fire station

Source: Ibid.

3.1.6. Church of Light and Sunday school by Tadao Ando, 1999

The Church of the Light in Japan is a cultural building which is comprised of two rectangular volumes that contain the Sunday school and worship hall. The concrete wall of the worship hall is cut in a cruciform shape which extends vertically from floor to ceiling and horizontally from wall to wall and is aligned with the joints in the concrete. Farrelly regards this cut as “a simple device, but an adequate definition of the space” and the cross becomes a symbol on the outside of the church as a consequence of light which pours from inside to outside at night.¹⁹¹

The traces of the joints and bolts, which present tactile impressions on the smooth, gray walls, provide insights about the construction processes of the building while these flat concrete surfaces allow the use of light as an architectural element through reflections.¹⁹² According to Fred Bernstein, Ando perfected his use of concrete and his vocabulary of forms which allowed him to design the heaviest wall appears to levitate that can be observed in his Church of the Light. For him, this building shows Ando’s virtuosity as a designer in concrete.¹⁹³

Although the main constitutive of the architectural tectonic of this buildings seems like the light, Tadao Ando’s the smooth concrete walls which reflect the light into the interior spaces illustrate how a fully comprehended material can originate a project. Also, concrete is a proper material to use it with tactile impressions on its surface that corresponds to the program of the building. How Ando reflects his design ideas through both the natural texture of the concrete and the traces from the construction process on the concrete’s surface which is aligned with the cruciform cut makes this church become another considerable concrete inspired case study.

¹⁹¹ Op. Cit., Farrelly, pg. 55.

¹⁹² Ibid.

¹⁹³ Fred Bernstein. Architecture: Celebrating the Past, Designing the Future, edited by Nancy B. Solomon. New York: Visual Reference Publications Inc., 2008, pg. 154.



Figure 3.11 Light pouring from the cruciform cut in the concrete wall of the Church of Light and Sunday school
Source: Op. Cit., Farrelly, pg. 56.

3.1.7. Sancaklar Mosque by Emre Arolat Architects, 2012

As quoted from Emre Arolat Architects in an online article, this building “aims to address the fundamental issues of designing a mosque by distancing itself from the current architectural discussions based on form and focusing solely on the essence of religious space.” The building is located in Istanbul, and the project site is parted from the surrounding communities by a highway and stone walls. To construct the building, which is located on a plaza made up of terraced steps, the combination of gray stone and reinforced concrete is used.

According to the design team "building blends in completely with the topography and the outside world is left behind as one moves through the landscape, down the hill and in between the walls to enter the mosque.” The sunken building is reached through earthen steps. At the lower level, the screen areas of the gardens are surrounded by a combination of concrete partitions, stone walls, and tall box. The center of the building is formed by a large concrete-lined prayer hall which features a tiered concrete floor and ceiling. Daylight is provided through the gap between the ribbed concrete wall which is located at the front of the prayer hall and the ceiling. According to design team "the interior of the mosque, a simple cave-like space, becomes an exciting and awe-inspiring place to pray and be alone with God.”¹⁹⁴

Structural features of concrete and stone in addition to textural properties of them constitute the architectural tectonics of this mosque. The integration of the building with the landscape where a tall minaret reaches to the sky, and the simplicity of the materials which is in harmony with the program and the surrounding environment of the building makes it an explanatory case study to understand the direct relation of materials to the building tectonics.

¹⁹⁴ Emre Arolat Architects as quoted in “Terraced Landscaping Surrounds Concrete and Stone Structure of Emre Arolat’s Sancaklar Mosque,” Dezeen Magazine, 2015, <http://www.dezeen.com/2015/04/06/sancaklar-mosque-emre-arolat-architects-istanbul-concrete-stone-terraced-landscaping/>, (June 30, 2016).



Figure 3.12 Stone roof and minaret of the Sancaklar Mosque

Source: “Sancaklar Mosque/ Emre Arolat Architects,” [ArchDaily](http://www.archdaily.com/516205/sancaklar-mosque-emre-arolat-architects), 2014, <http://www.archdaily.com/516205/sancaklar-mosque-emre-arolat-architects>, (June 30, 2016).



Figure 3.13 Tiered concrete ceiling of the prayer hall in the Sancaklar Mosque

Source: Ibid.

3.2. Indirect Influence of Materials on the Building Tectonics

“Architecture in a sense is all about materials. Material has to be used to complete architecture. Nothing is made without material. Things can be designed material-less, but to actually see if something will be feasible, material constraints will have to be assigned.”¹⁹⁵

The quotation above suggests that a structure or building can be designed without considering the materials at the first stage. However, the designer should select proper material, eventually, to bring the architectural design ideas, which include the tectonics that would be constructed, into being. For Yglesias, the design should not be considered as constituting forms in abstraction. He regards the design as a conjunctive exploration of forms and materials used to transform the design from being abstract object into a physical one. The technical characteristics and varying qualities of the materials provide thicknesses, vocabularies of edges, corners, and surface textures. As mentioned by him, being physical makes materials present to human’s senses as touch, or even smell and taste.¹⁹⁶ For example Neil Denari says:

“I’m really at this point a geometric sensualist and a kind of material expediter in that the materials we typically work with are selected for their ability to accentuate form. For me, materials have three basic conditions, of which the first two are most important: the visual phenomena of the surface, its workability (cutting, bending, shaping, etc.) and finally, its tactility. When you get into issues of the way in which the visual works, let’s say, in my work, which isn’t about tactility but at the same time it is deeply tactile at the level of process to construct with: tools and people coming together in various locations and sites in order to assemble something. That couldn’t be more tactile but it doesn’t necessarily predict whether or not someone wants to run their hands over the surface.”¹⁹⁷

¹⁹⁵ Zachary Ryan Schooley. Reversing the Process: Taking a Detail to a Design, Michigan: ProQuest, 2009, pg. 11.

¹⁹⁶ Op. Cit., Yglesias, pp. 1-2.

¹⁹⁷ Neil Denari as quoted in Matter: Material Processes in Architectural Production, edited by Gail Peter Borden and Michael Meredith. New York: Routledge, 2012, pg. 17.

According to Andrew Pressman, it is possible to connect a project to the site and region through applying local materials such as using gray-stained clapboard siding and white trim in New England which would provide harmonization of the building with rural coastal surroundings. Using indigenous materials can also provide cost advantage because of shorter distances and lower energy to the transportation of them. For materials selection, local climatic factors, labor pool and availability of craftspeople who know how to work with the local materials should be considered as well. Pressman presents material selection process' main criteria which are computability with design intentions and concept, life cycle of the material and cost, availability of the material and its relation to region and context, constructability and suitability to the function, weathering features and maintenance requirements, climatic response of the material and its degree of environmental sensitivity.¹⁹⁸

As discussed insofar, selecting proper materials according to the design inputs and considerations is essential since the intricate properties of materials affect the appearance and the atmosphere of the building environment. At this point, it can be illuminating to proceed with talking about some case studies which are selected from 20th and 21st centuries to clarify the indirect influence of materials on tectonics, since these design inputs and changing priorities among the design considerations will be explained and discussed in further thought in the fourth chapter.

3.2.1. Strawberry Vale School by Patkau Architects, 1995

Strawberry Vale School is a public school of which design is inspired by the vernacular language of rural buildings in combination with the surrounding nature. This environmentally sensitive building optimizes natural lighting by being oriented toward the south, minimizes site disturbance by the adjustment of the classroom pods with the land and rock outcroppings of the site and mediates the environmental

¹⁹⁸ Op. Cit., Pressman, pp. 82-83.

impacts through ecologist applications. For example, while collected rainwater in concrete trenches under the roof overhangs is discharged into a landscape swale that is planted with rough grass, the low point of the site are planted and monitored with plant species that are collected from surrounding marshlands. Furthermore, passive heat gain for heating, stack effect for ventilation and controlled placement of skylights, clerestories and windows for lighting are used as the natural systems in this building.¹⁹⁹

Regarding material usage, which is aimed to reduce the amount of energy that is embodied within the building, environmental sensitivity is considered again. Wood, as a local and the most readily accessible and renewable material, is used as the primary construction material both for structure and cladding of the building. Recycled steel and reinforced concrete are the secondary building materials for the additional structural requirements of the building.²⁰⁰



Figure 3.14 Strawberry Vale School’s wood cladding that makes the building well-matched with the surrounding forest

Source: “Strawberry Vale School,” [archello](http://www.archello.com/en/project/strawberry-vale-school), 2016, <http://www.archello.com/en/project/strawberry-vale-school> (August 10, 2016).

¹⁹⁹ Ibid.

²⁰⁰ Ibid.



Figures 3.15 (left), 3.16 (right) Natural lighting of the Strawberry Vale School's interior
Source: Ibid.

Since the form of the building is created to provide minimum site disturbance, sustainability and environmental sensitivity play a more evident role for the architectural form of this building than materials do. Material usage seems as the assistant element to engage with nature and the environment. The wooden structure and cladding makes the building well-matched with the surrounding forest.

3.2.2. Rosenthal Center for Contemporary Art by Zaha Hadid Architects, 2003

The Rosenthal Center, which is located on a busy street corner in the heart of Cincinnati, is designed by Hadid through a method of “Urban Carpet” that brings the fabric of the city within the museum’s walls as discussed by Luke Fiederer. While the lobby at the ground level is fully glazed and open to public and becomes a vital urban node in an existing network of public spaces and paths, the gallery spaces are formed according to “Jigsaw Puzzle” which means a complex arrangement of differently-sized concrete volumes in a three-dimensional puzzle way. The exhibition volumes are various in length, height, and lighting conditions as well as the material usage on their facades. The simplified shells represent the building program through

three material preferences which are concrete, glass and black metal panel. Through using distinct facades, Hadid reveals different properties of the interiors.²⁰¹

Since different materials are used to emphasize different building programs inside, this building exemplifies how physical features of the materials such as color and transparency affect the architectural language and helps to constitute a design concept.



Figure 3.17 Material usage on the facades of Rosenthal Center for Contemporary Art
Source: Luke Fiederer. “AD Classics: Rosenthal Center for Contemporary Art / Zaha Hadid Architects,” *ArchDaily*, 2016, <http://www.archdaily.com/786968/ad-classics-roenthal-center-for-contemporary-art-zaha-hadid-architects-usa>, (July 15, 2016).

²⁰¹ Ibid.

3.2.3. Solstice Arts Center by Grafton Architects, 2006

The architects of this building mention that this arts center is designed to create a new cultural anchor at the site in Navan, where acts like a void used mostly for car parking surrounded by two stone churches with their spires and dark purple slate roofs. A newly raised ground and an elevated walled garden are created while the theater occupies the space between while “an interior landscape,” is formed by the floor of the theater that follows the contours of the site. As design team notes, “the new arrival sets up a dynamic choreography, with the neighbouring public buildings and sets the scene for the re-instating of the historic market centre.”²⁰²

While natural daylighting and connection to the outside world is provided through the use of glass, limestone plinth is used to form the ground of south facing civic space. The wall around the theater with varying levels of opacity and transparency acts like a curtain which enables to see audiences as a shadow play. Also, the hovering grey-black marble mosaic slab over the civic space which is designed to invite people provides a connection between the building and the site. As design team explains “this material will fade over time and was chosen to match the color of the slated large roofscapes of the adjacent churches.”²⁰³

In similar with the previous case study, color and transparency of the materials provide the distinction of the different activities that take place inside the building. While the use of glass on the ground level provides visual connection between the occupants and the outside of the building, grey-black marble acts as a reference to the history and context of the surrounding buildings through providing uniformity with the roofs of existing churches.

²⁰² “Solstice Arts Centre / Grafton Architects,” *ArchDaily*, 2013, <http://www.archdaily.com/352502/solstice-arts-centre-grafton-architects>, (August 10, 2016).

²⁰³ Ibid.



Figure 3.18 Exterior view of Solstice Art Center

Source: [Archiseek](http://archiseek.com/2009/2006-solstice-arts-centre-navan-co-meath/), <http://archiseek.com/2009/2006-solstice-arts-centre-navan-co-meath/>, (August 11, 2016).



Figure 3.19 Grey-black marble mosaic slab over the civic space in uniformity with the surrounding buildings' roofs

Source: Ibid.

3.2.4. Raif Dinçök Yalova Cultural Center by Emre Arolat Architects, 2010

As noted in an online article, Yalova, where hosts Raif Dinçök Yalova Cultural Center, both presents natural and industrial layers. These two sides of the city are intertwined, and this opposition between them creates the unique soul of the city. In this case, the building, which is a cultural center, is designed to mediate the opposite layers of the city. According to Emre Arolat, the exterior of the building differs from “the shiny and dominant world of the recent cultural centers that want to monumentalize.” Also, “it holds off from this colorful, carefree yet imperious world”, because, it is aimed to teach the user with an open-ended design instead of forcing an order.²⁰⁴

The use of foraminous plates on the facade of the building and the rusty surface of this material represents the texture which can be observed in production areas in the region. By using this material, building starts to intertwine with the citizens. Also, this rusty material which can be recycled and acts as a natural palette changes its color by oxidation. Therefore, the relationship between city and building becomes more interactive. The semi-transparency of the material, which also acts as a barrier for the inner, lets it dissolve at the night time and interior of the building becomes readily perceivable. It allows air to ventilate the interior of the building. Different functions of the program are located in the precisely shaped masses with necessary dimensions in the building. These masses, which are connected by a ramp, are designed with varying geometries and as disconnected from the building facade and each other. The colorful and overgrown natural texture of Yalova is represented on the surfaces of the masses.²⁰⁵

²⁰⁴ Emre Arolat Architects as quoted in “Raif Dinçök Yalova Cultural Center/ Emre Arolat Architects,” *ArchDaily*, 2011, <http://www.archdaily.com/180305/raif-dinckok-yalova-cultural-center-emre-arolat-architects>, (June 29, 2016).

²⁰⁵ Ibid.

Therefore, it can be asserted that this building outstands as a remarkable example of material usage to connect a project to its region and users. It gains its environmentally sensitive status with the assistance of an inventive use of covering material while this material also provides a semi-transparent connection between interior and exterior. It is almost impossible to imagine same building that would create the same spiritual atmosphere in anywhere else by means of the connection of the site, history and culture with the building that is constituted by the rusty material which makes this center as a natural part of the environment through a natural process, oxidation.



Figure 3.20 Semi-transparent, rusty facade of Raif Dinçök Yalova Cultural Center
Source: Ibid.

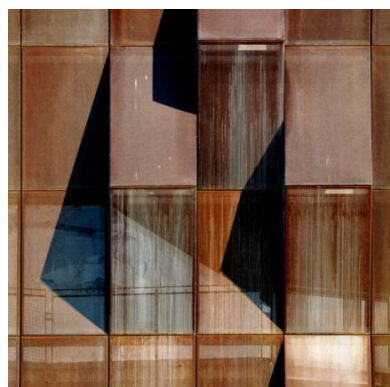


Figure 3.21 Closer view of the cladding material, which changes color by oxidation, used on Raif Dinçök Yalova Cultural Center's facade
Source: Ibid.

3.2.5. Dialogue in the Dark Bukchon by Wise Architecture, 2015

This exhibition building, the Dialogue in the Dark Bukchon, is designed to make a visitor experience everyday life in complete darkness. Since it turns off a sense of sight, other senses such as touching different materials that are applied inside the building are used to recall different spaces in the building. As design team says “at the beginning of the process, we wondered how the visually impaired people recognize space; we found out that they memorize space by touching over and over again and reconstruct it in their memory.”²⁰⁶

Because of the level difference on the site and rock bed under the ground, the building is placed on the ground. Therefore, it becomes possible to reflect the building program on the exterior through material usage. The exhibition that expands sensual experience of the visitors is symbolized on the building facade by means of the Korean traditional screen which is entitled as ‘Bal.’ This screen, which admits light while it also acts as a blind that controls visual connection between the outside and inside, represents the identity of the exhibition.²⁰⁷

This building is a remarkable example of human-centered design, which has become more important in architecture as a result of post-industrial thought. It exemplifies how materials influence the concept of the design through color, transparency, and texture that interact with the human senses. Since semi-transparent cladding material provides all visual connection, the perception of the darkness and historical references to the site, it helps to constitute to the tectonics of the building.

²⁰⁶ Paul Keskeys. “Designing for the Blind: WISE Architecture's Dialogue in the Dark Bukchon,” *Architizer*, 2015, <http://architizer.com/blog/dialogue-in-the-dark/>, (August 10, 2016).

²⁰⁷ “Dialogue in the Dark Bukchon / Wise Architecture,” *ArchDaily*, 2015, <http://www.archdaily.com/638801/dialogue-in-the-dark-bukchon-wise-architecture>, (August 10, 2016).



Figure 3.22 Exterior view of Dialogue in the Dark Bukchon
Source: Ibid.



Figure 3.23 Interior view of Dialogue in the Dark Bukchon demonstrating different material usages
Source: Ibid.

3.3. Independent Influence of Material on Architectural Language and the Building Tectonics

For Denise Scott Brown, Steven Izenour, and Robert Venturi, the design idea that constitutes the present-day modern architecture should be turned from the John Ruskin's statement that is "architecture is the decoration of construction" into the warning of Pugin who mentions that "it is all right to decorate construction, but never construct decoration."²⁰⁸ Architecture is attached to the perception and initiation of the experience and emotional connection. The symbolic and representational value of architecture may be inconsistent with the structure, form, and program of the same building. As mentioned by Brown, Izenour, and Venturi, this situation can arise in two situations which are titled as "duck" and "decorated shed." While duck is described as the particular building which is a symbol, decorated shed means an ordinary shelter that applies symbols.²⁰⁹

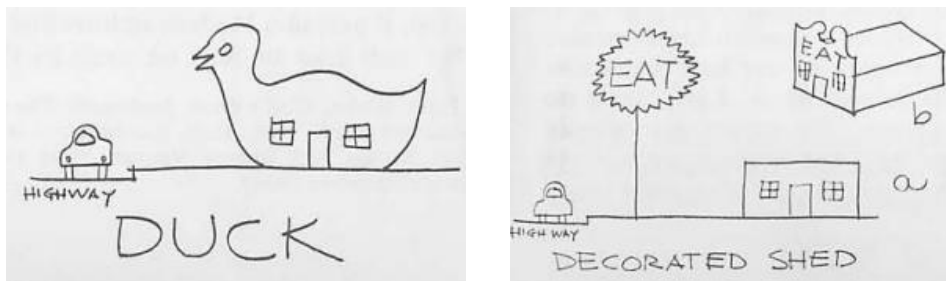


Figure 3.24 (left) Sketch of the duck, a special building as a symbol

Source: Denise Scott Brown, Steven Izenour, Robert Venturi. Learning from Las Vegas: The Forgotten Symbolism of Architectural Form, revised edition, Cambridge and London: The MIT Press, 1977, pg. 88.

Figure 3.25 (right) Sketch of the decorated shed, a conventional shelter that applies symbols

Source: Ibid., pg. 89.

²⁰⁸ Op. Cit., Brown, Izenour, Venturi, pg. 163.

²⁰⁹ Ibid., pg. 87.

The notion of “architecture of communication through signs over space,” leaves the back of the building styleless because no one sees the back, while the front is applied to signs, messages, and advertisements.²¹⁰ Today, this kind of architecture, which is referred as “the material usage free from the tectonics” in this study, has started to penetrate the whole built environment regardless to the tectonics of architecture. Venturi’s decorated shed and even ducks, or the scenography in architecture as discussed by Frampton²¹¹ can be considered as a proper match with the current ornamental facades of present-day buildings.

Even current architecture is rejecting the use of explicit symbolism and ornament, the whole building itself has become the one big ornament itself²¹² as mentioned in the “Learning from Las Vegas,” which was written in the 1970s. Today, this transformation of architecture into an ornament is more apparent with iconography and electronic screens on the buildings for the sake of “bigger profits.”²¹³

“Twenty-five years ago Las Vegas consisted of downtown with a Main Street (Fremont Street) and the Strip in the desert. Today downtown is still pretty much downtown, but the Strip—oops, the Boulevard—with its urban-scenographic accessories, has become in some ways the equivalent of the shopping mall that accommodates the pedestrian in safe and explicitly artificial environments.”²¹⁴

According to Brown, Izenour, and Venturi, the unique and monumental parts of the Strip of Las Vegas were the most changeable parts as well because “good advertising technique requires the differentiation of the product.”²¹⁵ The same logic of producing marketed but temporary, standardized building, for which materials have been used

²¹⁰ Ibid., pp. 8-35.

²¹¹ See Op. Cit., Frampton.

²¹² Op. Cit., Brown, Izenour, Venturi, pg. 103.

²¹³ See Robert Venturi. Iconography and Electronics upon a Generic Architecture: A View from the Drafting Room, Cambridge and London: The MIT Press, 1996.

²¹⁴ Ibid., pg. 127.

²¹⁵ Op. Cit., Brown, Izenour, Venturi, pg. 34.

just to create advertising images, is even more valid in present day architecture. Especially applying standardized cladding glass, which can be regarded as the very image of any symbol on the decorated shed, on the facades of the buildings regardless of their form, structure or function has become almost a norm of commercial architecture. For example, Andrew Ballantyne and Chris L. Smith says:

“In established town centres there is often an insistence on more traditional materials that match the older buildings, but out of town the steel-framed, glass-clad buildings are everywhere, often housing useful facilities. It is safe to say that they are hardly ever loved as buildings, but we keep building them because they answer the imperatives of the non-human system that humans sustain. They are flexible, adaptable and predictable (which is to say reliable). They cost significantly less money to build than would buildings of the same size made with traditional materials, and they can be put up far more quickly, their components coming from wherever in the world they are currently available at the best price. The appealing thing about these buildings is not on the plane of human experience, but on the plane of capital.”²¹⁶

Consequently, it can be proposed that regardless the motivation behind this packaging in architecture and the type of marketing skins on the buildings (electronic screens, printed materials, glass cladding or anything else) the result of the “vast quantity of similar construction which has been a feeling created in the minds of people a boring monotony,”²¹⁷ should be reviewed (See Figure 4.13, Figure 4.14).

3.3.1. The Portland Building by Michael Graves, 1982

The Portland Building of Michael Graves, which exhibits prolific symbolic elements on its monumental facades, is thought to be Postmodernist architecture’s first major building as raised by Gili Merin. According to her, many architects, as well as the

²¹⁶ Architecture in the Space of Flows, edited by Andrew Ballantyne and Chris L. Smith. London and New York: Routledge, 2012, pg. 33

²¹⁷ Doreen Yarwood. A Chronology of Western Architecture, New York: Dover Publications, 2010, pg. 206.

Portlanders, have already criticized this building because of its highly-styled elements, excessive symbolism, and references to the past and unfunctional traditional elements on the facades. The arcades that the design incorporates provide only two entries set above street level. Also, two small doors on the park-facing facade are offered to enter a windowless restaurant and a back lobby. The office spaces are dark and claustrophobic as unpleasant as the lobby.²¹⁸



Figure 3.26 Exterior view of the Portland Building with decorations on its facade

Source: Gili Merin. “AD Classics: The Portland Building / Michael Graves,” *ArchDaily*, 2013, <http://www.archdaily.com/407522/ad-classics-the-portland-building-michael-graves>, (June 28, 2016).

²¹⁸ Op. Cit., Merin.

Therefore, it can be asserted Portland Service Building stands as a reproachable product of material usage regarding tectonics. It seems that the design idea that has formed the Portland building, which is still valid in the 2000s, subdues the materiality. It only aims to display a facade which is fully decorated regardless to the function, structure or the program of the building. For example, the strip coverings with a cap on them appear as a two-dimensional drawing of a column with a capital which seems as a complete figurativeness since they are not the actual structural elements of the building.

3.3.2. Clayton County HQ Library by Mack S. Merrill Elam Architects, 1988

“Sitting in the small office, on worn-out and mismatched furniture, the architects noticed the speckled box. It was a small, paper-covered box sitting on the desk. In a librarian's cramped and cluttered office, the box seemed unique and, somehow, brilliant. "It was," explained architect Merrill Elam, "a really good-looking paper that the box was wrapped in. It was a gray-speckled, traditional librarian's box."²¹⁹

According to the architects, this library is designed as a filling-station for information for living life. Therefore, it is inspired by a library box which seems related to the building program.²²⁰

However, within the frame of material usage, the design idea, which is stated above, makes possible to think this building as a decorated shed and even a duck of the 1980s. In addition to its remote material application on the facade, this proposition can also be enhanced by the ‘library’ sign at the front of the stairs that lead to the building. This building can be criticized because of its corrugated steel cover (that is painted in black and white patches) which attempts to resemble a library box that can be found anywhere with the same shape, colors, and texture.

²¹⁹ Daniel Siliman. *Clayton News-Daily*, 2008, http://www.news-daily.com/news/library-s-avant-garde-architecture-stands-test-of-time/article_d8e546c9-ccae-5b17-b84d-3f85b7523e1e.html, (June 29, 2016).

²²⁰ Ibid.



Figure 3.27 Traditional librarian box as the origin of the project

Source: Mack Scogin Merrill Elam Architects, <http://msmearch.com/type/libraries/clayton-county-headquarters-library>, (July 11, 2016).



Figure 3.28 (left) 'Library' sign in front of the Clayton County HQ Library

Source: Ibid.

Figure 3.29 (right) Painted in black and white corrugated steel covering on the exterior of the Clayton County HQ Library

Source: Ibid.

3.3.3. The Guggenheim Museum Bilbao by Frank Gehry, 1997

“Every struggling post-industrial city has the same idea: hire a star architect (like Frank Gehry) to design a branch of a famous museum (like the Guggenheim), and watch your city blossom with culture. After all, it worked for Bilbao ... didn't it?”²²¹

For Brian Pagnotta, the metallic form of the Guggenheim Museum Bilbao, which is formed by random curves, resembles a boat to refer the past industrial life of the port of Bilbao. For him, the building captivates materiality that responds to an industrial urban context.²²² Although Pagnotta's statement offers that materiality was considered issue for the design of Guggenheim Museum, it seems contradictory to the statements of Chris Michael who seems more credible on this issue. According to Michael, there are clients who want to copy this building. If the materiality of the museum to represent the history of the Bilbao was legal, Gehry should not have let anyone copy his design to be constructed in anywhere else. However, Gehry accepted the deal if the clients were willing to pay a lot.²²³

As can be seen in Figure 3.30 and Figure 3.31, the facade of the Guggenheim Museum in Bilbao seems barely different from the facade of Weisman Art Museum in Minneapolis although an architect should consider the relationship between the material usage and regional context of the architectural project. At this point, it can be proposed that for the sake of image, the aesthetical concerns are divorced from the structural concerns which results in the subdued regard of materiality in this building. Also, the resemblance between the non-structural metal claddings of Gehry's buildings makes possible to see them as 'hit' buildings where the material usage on the facades is irrelevant to the tectonics.

²²¹ Chris Michael. <https://www.theguardian.com/cities/2015/apr/30/bilbao-effect-gehry-guggenheim-history-cities-50-buildings>, (July 11, 2016).

²²² Brian Pagnotta. “AD Classics: The Guggenheim Museum Bilbao / Frank Gehry,” *ArchDaily*, 2013, <http://www.archdaily.com/422470/ad-classics-the-guggenheim-museum-bilbao-frank-gehry>, (July 11, 2016).

²²³ Op. Cit., Michael.



Figure 3.30 Exterior view of the Guggenheim Museum Bilbao with non-structural metal cladding

Source: Op. Cit., Pagnotta.



Figure 3.31 Exterior view of the Weisman Art Museum in Minneapolis with non-structural metal cladding

Source: <http://www.architectmagazine.com/project-gallery/weisman-art-museum-6463>, (July 11, 2016).

3.3.4. Eberswalde Technical School Library by Herzog and de Meuron, 1999

Eberswalde Technical School Library is designed as a simple rectangular building which includes three similar stories for free access libraries. According to Herzog and de Meuron, the glazed exterior of the building provides a relationship between the existing historic building and the library. The glass panels are imprinted with photographic motifs by using screen-printing and the prefabricated concrete panels are similar to these glass panels²²⁴ which makes hard to realize the difference between two materials and turns the building into an object of the showcase.



Figure 3.32 Inconceivableness of the concrete and glass panels on the facade of Eberswalde Technical School Library

Source: Herzog de Meuron, <https://www.herzogdemeuron.com/index/projects/complete-works/101-125/105-eberswalde-technical-school-library.html>, (July 17, 2016).

²²⁴ Ibid.

According to Christian Schittich, Eberswalde Technical School Library is “the most radical form of a decorated box.” The panels, which are decorated with selected images by Thomas Ruff in relation to history, art, and science, are repeated 66 times in horizontal arrangement while they transform the facade into a projection screen.²²⁵ The images on the envelope include a photograph of young women, a father with his children, a prototype of an aircraft, a photograph of Haus am Horn in Weimar, students working in a library and as such.²²⁶ Although some of them are related to the building program to make the facade tell a story, as mentioned by Schittich, “they communicate very little with regard to the context of the building.”²²⁷

Although it can be asserted that an architect can intentionally prefer to use printed images on a building, the cladding of the building is criticized in this study as an example of fraudulent and dishonest use of materials that makes architectural intentions independent from the tectonics of the building. Concrete and glass seem indistinct because of the images, which efface both the differences of two materials in terms of transparency, color and texture.

3.3.5. Artistic amenity Stadshaard by Cie., 2009

The Artistic amenity Stadshaard is a power station which is designed to develop an environmental sensibility.²²⁸ According to the architects of the building, it is an eye-stopper and a point of reference building which acts as a gateway to the district of Roombeek. As mentioned by them, neutral industrial structures are often situated at the locations where are away from the city centers while the Stadshaard is located at

²²⁵ *In Detail: Building Skins*, edited by Christian Schittich, translated by Peter Green and Ingrid Taylor. Basel, Boston, and Berlin: Birkhäuser, 2006, pp. 23-24.

²²⁶ Op. Cit., Löscke, pp. 19-20.

²²⁷ Ibid.

²²⁸ Architekten Cie. as quoted in “Artistic amenity Stadshaard / Cie.,” *ArchDaily*, 2010, <http://www.archdaily.com/67515/artistic-amenity-stadshaard-cie/>, (July 17, 2016).

a prominent spot in Roombeek. Therefore, the site of the building can be regarded as the architects' questionable reason to legitimize turning the facades into a projection screen. The architects say that the square panels with motifs are reminiscent of the delftware tiles which often have figurative motifs that are abstractions of the daily-life activities.²²⁹

Although the expressive motifs and symbolic depictions on the facades give a little idea about the program of the building, it still appears as a product of any manufacturer. Therefore, in terms of the discussions made insofar, this building stands as another decorated box with the expressive images on it. Therefore it becomes meaningful to think that same images can be applied on a paper cup, which would be a trash after it becomes empty, since even the material used on the facade resembles paper.



Figure 3.33 (left) Exterior view of the Artistic amenity Stadshaard in the district of Roombeek

Source: Ibid.

Figure 3.34 (right) Example of the printed images on the facade

Source: Ibid.

²²⁹ Ibid.

3.3.6. Library of Birmingham by Mecanoo, 2013

As mentioned by Christopher Henry, the metal cladding, which is asserted to represent Birmingham's industrial growth, covers the facades of the building.²³⁰ Since "the goldy-glittery exterior is a bit Vegas,"²³¹ and is designed just to exhibit the surface, the Library of Birmingham is more of an advertisement than a building. For Stephen Bayley, "the state of public building is a measure of a nation's psychic health," and this building is more a metropolitan trophy rather than space which is designed for reading and learning. While evaluating this building, Bayley also refers to the Frank Gehry's Bilbao Guggenheim Museum which he regards as a 'hip' rather than an art gallery and adds that "Birmingham's latest public building is a result of the city chasing the Guggenheim Effect with a demand for popular monuments."²³²

As discussed throughout this study, the essence of architecture is being related to a particular place, history, culture, and values. However, the material usage on the facades of the Library of Birmingham, which is entirely unattached to the structure of the building and the function of the interior spaces, appears contradictory to that essence. The intersecting circles produced through mass-production methods seem applicable to any building irrelevantly to the context. The evidential reasoning for this statement can be considered as the resemblance between the facades of Library of Birmingham and Armada Shopping Center in Ankara as can be seen in Figure 3.35 and Figure 3.36.

²³⁰ Christopher Henry. "In Progress: Library of Birmingham / Mecanoo architecten," *ArchDaily*, 2011, <http://www.archdaily.com/169492/in-progress-library-of-birmingham-mecanoo-architecten/>, (July 29, 2016).

²³¹ Rowan Moore as cited in James Taylor- Foster. "Critics React to Mecanoo's Birmingham Library," *ArchDaily*, 2013, <http://www.archdaily.com/426491/critics-react-to-mecanoo-s-birmingham-library>, (July 29, 2016).

²³² Stephen Bayley as cited in *Ibid*.



Figure 3.35 Exterior view of the Library of Birmingham
Source: Ibid.



Figure 3.36 Intersecting circles on the facade of Armada Shopping Center in Ankara
Source: Photographed by the author.

Table 3.1 Comparison of the three usages of materials according to their relatedness to the building tectonics, regarding architectural design intentions, considerations, production methods and outcomes in terms of architectural ‘spirit’

Source: Arranged by the author according to the discussions in the third chapter based on the literature reviews and case studies

Direct Influence	Indirect Influence	Independent Influence
Related with the tectonics, constitutes both structure and architectural language in terms of appearance	Related with the tectonics, constitutes architectural language in terms of appearance in relation to the structure	Unattached from the tectonics, constitutes only outer appearance unrelated with the structure
Ontological tectonics	Representational tectonics	Scenography
Architectural design inspired by the inherent features, especially structural qualities, honest use of the materials	Most appropriate materials selected after design is formed according to considerations and design intentions, honest use of materials	Mostly cheapest and available within the shortest time materials, dishonest use of materials
Gives references to a particular place, history, and culture to constitute an architectural essence		No specification about the site, history or culture, possible to build anywhere else
Structural, formal and functional considerations		Money-minded, mostly economical considerations
Mostly customized parts, customized architectural design		Mostly mass-produced parts and similar design
Long-lasting, unique and qualified buildings designed in a three-dimensional way regarding volume and plan as well as the surface, even hand-crafted ‘model’ ²³³ that is produced as unique		Formalist and ‘enigmatic’ to attract attention, ephemeral commodified ‘object’ ²³⁴ with two-dimensional branding package on it regarding only surface, decorated shed of the current Age of Consumerism

²³³ See Jean Baudrillard. The System of Objects, translated by James Benedict, London and New York: Verso, 1996.

²³⁴ Ibid.

CHAPTER 4

DETERMINATIVE LIMITS OF THE MATERIALS SELECTION IN ARCHITECTURAL DESIGN PROCESS

The increase in the population as well as the industrial production and the raise in the mechanization of productive systems have necessitated larger architectural products such as roads, bridges or buildings with more efficient systems.²³⁵ Therefore, the pattern of material usage has changed throughout the history beginning with the industrial revolution as discussed with the reviews of Benevolo in the second chapter of this study. Hence, it is possible to note that economical interest, which will be discussed in details in the forthcoming parts, became the dominant selection factor for materials in architecture. J. Charles and F. Crane say:

“The pattern of materials usage is constantly changing and the rate of change is increasing. Whereas the succession of Stone, Bronze and Steel Ages can be measured in millennia, the flow of present-day materials development causes changes in decades; there may also be changes in the criteria that determine whether or not a particular material can be put into large-scale use. In the past these criteria have been simply the availability of the basic raw materials and the technological skills of the chemist, metallurgist and engineer in converting them into useful artefacts at acceptable ‘cost’, leading to the present situation in which the most important materials are still steel, concrete and timber but supplemented by a constantly increasing range of others.”²³⁶

The change in the selection factor for materials affected the architectural design process. Before considering this case, it is useful to discuss the place of materials

²³⁵ Op. Cit., Benevolo.

²³⁶ James Charles and Frederick A. A. Crane. Selection and Use of Materials, 2nd edition, Oxford: Butterworth-Heinemann Ltd., 1989, pp. 6-7.

selection in the design process. As noted in the previous chapter of this study, materials either inspire a building project in which whole architectural design is created according to specific materials and their existential properties or are selected as assisting elements for the project after designing the building. In both cases, consideration of materials takes an essential part in the design process. According to Charles and Crane, all the materials and manufacturing methods, which are available for use, should be regarded to produce an innovative design.²³⁷



Figure 4.1 Materials selection in the architectural design process

Source: “Architects/ Engineers/ Construction,” 2012, <http://www.manningsearchgroup.org/wp-content/uploads/2012/09/design.jpg>, (June 5, 2016)

They explain that, mainly, decision-making part, which is described as “the part of the process in which the designer makes choices concerning such matters as dimensions and dimensional tolerances, materials and manufacturing methods,”²³⁸

²³⁷ Op. Cit., Charles and Crane, pg. 13.

²³⁸ Ibid., pg. 10.

involves the materials selection part in the design processes.²³⁹ For them, this section of the process demands more technical information. Material properties, specific features of different manufacturing methods and a databank of stress-analysis formulae should be used in this part. Beside decision-making part, in the synthesis stage of the design process, which is described as “involving the searching out and bringing together of sufficient basic ideas for the achievement of function to an acceptable degree”²⁴⁰, the materials selection should be considered as well. To appreciate the materials implications of any design innovations entirely at the earliest stage is critical.²⁴¹

Although the cost has become the primary factor to select materials for projects commonly, there have been other examples, some of which are mentioned in case studies in the third chapter of this study, with materials selection concerning the architectural design inputs such as form, function, shape, color and as such. There are also other factors, such as the total energy cost and recycling issues about the materials²⁴², which would influence materials selection more evidently in the future. Therefore, the selection factors will be examined in three parts which will cover materials selection according to physical design inputs (that refer line, form, space, color, light, texture, and materials), economical reasons, and environmental sensitivity in combination with sustainability issues.

4.1. Materials Selection According to Physical Design Inputs

“Because materials are familiar in experience and unavoidable in construction one might assume this specification is a procedure that can be described simply and

²³⁹ Ibid., pg. 13.

²⁴⁰ Ibid., pg. 10.

²⁴¹ Ibid., pg. 13.

²⁴² Ibid., pg. 7.

clearly; in fact the opposite is true, for it is both a rarely discussed procedure and one that exposes strikingly obscure and indefinite thinking when questioned. Yet this obscurity is unavoidable because material selection is inevitable.²⁴³

Emmitt and Yeomans note that designers generally focus on the finished appearance of the buildings while they pay a little attention to the process of producing the building and the selection of building products and materials. However, materials should be an inherent part of the designer's design idea even they can select the materials on later stages of the design process. For them, correct selection of materials, components, and products provides a good architectural design and this selection makes up a building's assembly.²⁴⁴ In the book entitled "Drafting and Design for Architecture and Construction," material, which constitutes and affects other design components, is regarded as one of the architectural input.²⁴⁵ Therefore, as discussed insofar, to construct a building with its designed parts, materials selection is essential. In the following part, architectural design components and their relation to the materials will be discussed.

4.1.1. Physical Inputs of the Design and Their Relation to the Materials

Design is composed of many elements which include line, form, space, color, light, texture, and materials. These essential parts are the tools of architectural design.²⁴⁶ In this part, these mediums will be briefly described with existing buildings to understand their relationship with the materials.

²⁴³ David Leatherbarrow as quoted in Stephen Emmitt and David Yeomans. Specifying Buildings: A Design Management Perspective, Oxford: Taylor & Francis Ltd., 2001, pg. 13.

²⁴⁴ Ibid.

²⁴⁵ Dana Hepler, Donald Hepler and Paul Wallach. Drafting and Design for Architecture and Construction, USA: Cengage Learning, 2012, pg. 22.

²⁴⁶ Op. Cit., Hepler, Hepler and Wallach.

According to Dana Hepler, Paul Wallach, and Donald Hepler, the contour or outline of the architectural forms is defined by ‘lines’ which are straight or curved ones. According to its type, it can create senses such as height, length or movement. For example, while vertical lines can produce a sense of height and horizontal lines can indicate a sense of width, curved lines represent soft and flowing movements.



Figure 4.2 (left) Empire State Building, for which reinforced concrete that enables to construct high buildings, as an example of vertical line use

Source: Nicolás Valencia. “These Are the World’s 25 Tallest Buildings,” *ArchDaily*, translated by Katie Watkins, 2015, <http://www.archdaily.com/779178/these-are-the-worlds-25-tallest-buildings>, (June 29, 2016).

Figure 4.3 (right) Heydar Aliyev Center, for which glass fibre reinforced concrete and glass fibre reinforced polyester were used due to their plasticity that enable to construct curved forms

Source: “Heydar Aliyev Center/ Zaha Hadid Architects,” *ArchDaily*, 2013, <http://www.archdaily.com/448774/heydar-aliyev-center-zaha-hadid-architects>, (June 29, 2016).

The second element is ‘form’ which is created through shapes that are defined by joining lines together in a three-dimensional way. For them, the relationship between these forms and shapes is essential. They add that form is both surrounded and filled by another design element, ‘space.’ As mentioned, defining space as the actual object

and material, and space relationships are critical considerations in architectural design. The fourth design input explained by Hepler, Wallach and Hepler is ‘color,’ which may be an integral part of the material and influences the final appearance of any design. Color may be added to the manufactured products and materials, which will be used in the building, to produce desired effects. ‘Light’ is another architectural element, they mention, which can create a dramatic effect by reflecting from surfaces and giving a sense of depth to a structure. Therefore, the surface of materials is necessary to consider for the designer.²⁴⁷



Figure 4.4 Kohl Children’s Museum as an example of form creating a space with the aid of light reflections through cladding material’s surface

Source: <http://www.boothhansen.com.php53-14.dfw1-1.websitetestlink.com/projects/kohl-children%E2%80%99s-museum/>, (June 29, 2016).

²⁴⁷ Ibid., pp. 22-25.



Figure 4.5 Central St. Giles Court as an example of color added material usage in architecture

Source: “Central St. Giles Court / Renzo Piano + Fletcher Priest Architects,” *ArchDaily*, 2011, <http://www.archdaily.com/104147/central-st-giles-court-renzo-piano-fletcher-priest-architects>, (June 29, 2016).



Figure 4.6 Therme Vals as an example of light creating the sense of depth through the surfaces of material used on the walls

Source: Thomas Schielke. “Light Matters: Heightening the Perception of Daylight with Henry Plummer, Part 1,” *ArchDaily*, 2015, <http://www.archdaily.com/626181/light-matters-heightening-the-perception-of-daylight-with-henry-plummer-part-1>, (June 29, 2016).

The final architectural design element which is considered by Hepler, Wallach and Hepler is material as the raw substance of the architectural design. Hence materials have their properties such as form, dimension, color, degree of hardness and texture; they are automatically related with the other design elements. For example, texture, which refers to the surface finish of an object, is a major factor in selecting proper materials. The surface can be rough, smooth, coarse or fine based on the chosen material and these different types of surfaces can create different senses; such as strength and informality which is suggested by rough and dull surfaces, or luxury and formality which is caused by smooth surfaces.²⁴⁸



Figure 4.7 (left) Masonry texture dominating the design in the House in Tinos

Source: “House in Tinos/ mX Architecture,” [ArchDaily](http://www.archdaily.com/54044/house-in-tinos-mx-architecture), 2010, <http://www.archdaily.com/54044/house-in-tinos-mx-architecture>, (June 29, 2016).

Figure 4.8 (right) Different textures of materials during the refurbishment of the West Tower in Huesca City Hall

Source: “Refurbishment of the West Tower in Huesca City Hall/ ACXT,” [ArchDaily](http://www.archdaily.com/276131/refurbishment-of-the-west-tower-in-huesca-city-hall-acxt), 2012, <http://www.archdaily.com/276131/refurbishment-of-the-west-tower-in-huesca-city-hall-acxt>, (June 29, 2016).

²⁴⁸ Op. Cit., Charles and Crane, pp. 25-26.

4.1.2. Importance of Experiencing Materials' Properties

According to Schröpher, a material offers opportunities and limitations through its properties such as transparency, texture, elasticity, fluidity and fragility while working with it. By experimentations, it is possible to understand material's ability to stretch, bend, hold its shape, and withstand external forces. Thus, it becomes practicable to operate the material with aggregation, weaving, modulation, and any other action which would be performed according to designer's goal. Just as the material itself, material process which refers an operational logic is scale-less and therefore, it is possible to apply this functional logic from the detail to the building scale and beyond.²⁴⁹

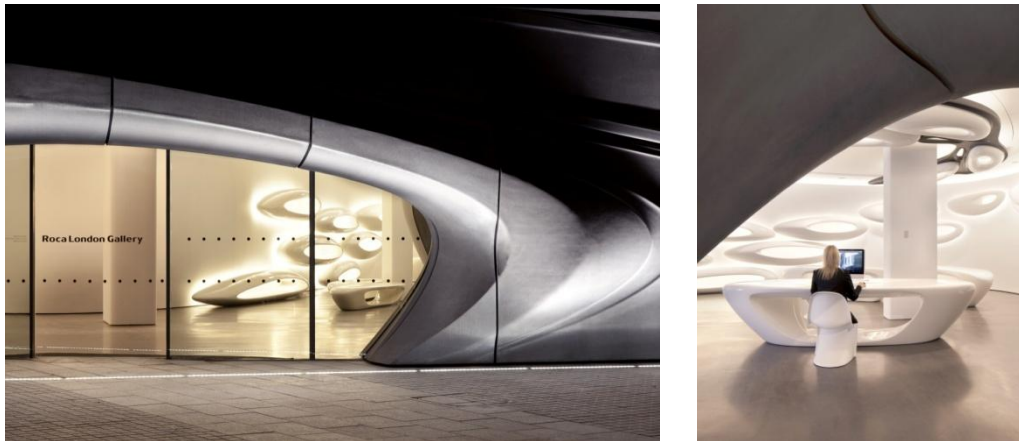


Figure 4.9 (left) Roca London Gallery by Zaha Hadid Architects, application of the same operational logic in material process from furniture to the building

Source: “Roca London Gallery/ Zaha Hadid Architects,” *ArchDaily*, 2011, <http://www.archdaily.com/179092/roca-london-gallery-zaha-hadid-architects>, (June 29, 2016).

Figure 4.10 (right) Furniture, which is designed specifically, in the Roca London Gallery by Zaha Hadid Architects

Source: Ibid.

²⁴⁹ Op. Cit., Schröpher, pg. 30.

As comprehended insofar, materials have a wide range of properties and examining them provides many opportunities. Also, it should be considered that it is not sufficient for a designer to choose a material by relying on an absolute requirement for one property above all others. Certain backup features should be considered by the designer as well. In this case, materials which possess a combination of properties can be regarded as the useful ones in the design process. Although there are exceptions, materials can be grouped or generalized according to their individual combinations of properties.²⁵⁰

Brief information about the materials, as exemplified in the previous paragraph, can provide an overall perception to the designer. For a particular function, the designer should have different materials options at an early stage in the design process to choose between them. The property required should be well-understood regarding fundamental science. However, it should also be considered that not all material properties can be fully understood in this sort. As noted by Charles and Crane as an example, weldability of metals should be measured to apply them in a project. Yet, it is not possible to do it with a single parameter because of the existence of many processes that can reveal different results from each other in terms of the overall response of the material. Still, to select a proper material in a rational way, the properties should be examined to see differences. As an outcome, two types of property parameters which are fundamental parameters and ranking parameters. While key parameters involve basic properties of materials and can be used directly in design calculations, ranking parameters may be used to rank materials in terms of superiority and cannot be used directly in design calculations.²⁵¹

Although generalizations and descriptions of materials' properties, which are discussed in previous paragraphs, can help a designer to select among many materials, experiencing the nature of materials with senses can be regarded as more instructive. For Schröpher, the experimentation by students and practitioners

²⁵⁰ Op. Cit., Charles and Crane, pg. 1.

²⁵¹ See Ibid., pg. 2 for more explanation on fundamental parameters and ranking parameters.

contributes the understanding of materials' properties. Still, 1:1 material investigations throughout the discipline should be realized for further understanding. He argues that, these 1:1 kinds of advanced studies should be encouraged by architectural education systems. As discussed by him, since the days of early modernism, 1:1 material studies have existed. Schröpher exemplifies these studies through the statements of Johannes Itten, who was an educator at the Bauhaus and mindful of materials in an architect's education and gave a course about materials to demonstrate the nature of materials as well as to make students experience materials' character.²⁵² About this course Itten says:

“In the Basic Course at the Bauhaus exercises with materials and textures were found particularly stimulating. As an introduction long lists of the various materials such as wood, glass, fabrics, bark, furs, metals, and stones were compiled. I then had the visual and tactile sensations of these materials entered against them in further columns. But knowledge of the words describing the properties was not enough; it was necessary to experience and to demonstrate the character of the materials. Contrasts such as smooth-rough, hard-soft, light-heavy had not only to be seen, but also felt. I have always laid particular stress on the comprehension by the senses of the typical properties of all objects. When, some time later, I was in charge of a course to introduce architects, painters, and teachers to the problems of the Bauhaus Basic Course, the first exercise I set was a still life. Two yellow lemons lay on a white plate, to which I added a book with a green cover. The members of the course felt almost insulted that they should be asked to draw something so simple. The outlines were laid down with a few quick strokes, and then everybody looked at me questioningly, without doubt expecting me to give them an introduction to geometrical problems of form. Without a word I picked up the lemon cut it up and gave each member of the course a slice to eat, asking him: ‘Have you reproduced the essence of the lemon in your drawing?’ The answer was a sweet-sour smile and everyone began afresh to study the still life intensely.”²⁵³

Schröpher adds that today, there are various working on more generic studies of materials in architectural education, such as practices in the constantly updated library of materials and material applications of Harvard University's Graduate School of Design. By keeping records of material experimentation and active

²⁵² Op. Cit., Schröpher, pp. 30-32.

²⁵³ Johannes Itten as quoted in Ibid.

explorations in the library, students are provided with the opportunity of working on their predecessors' studies as well as experiencing materials by handling. Schröpher's other examples for material libraries include New York-based material library Material ConneXion, the Paris-based matériO, and the Swiss Material Archiv.²⁵⁴ Also, according to Bell and Rand, new materials and new uses for the existing ones are being continually generated by global corporations like DuPont and Weyerhaeuser, as a result of comprehending the importance of material studies. As told by them, "Once merely a tool for architects and mostly confined to the realm of engineering, materiality has now become an instrumental methodology for a clear and bold design statement."²⁵⁵



Figure 4.11 Material library, Material ConneXion

Source: <https://massartlibrary.files.wordpress.com/2012/03/mc.jpg>, (June 29, 2016).

After all, studying and experiencing the properties of materials is significant to contribute the architectural design process actually. The architectural material palette has been limited by simple classification methods and by a lack of integrated

²⁵⁴ Ibid.

²⁵⁵ Op. Cit., Bell and Rand.

disciplinary exploration. Material experimentations and innovation should be advanced to express 21st-century desires such as more complexity, crafty and increasingly tailored architectural experiences.²⁵⁶ As indicated by Schröpher, “Being an architect means being an intermediary, the connecting link between ideas and materials.” Therefore penetrating the nature and properties of materials is a responsibility for him.²⁵⁷



Figure 4.12 Material applications in the Harvard University's Graduate School of Design

Source: <http://www.gsd.harvard.edu/images/content/6/2/v2/629177.jpg>, (June 29, 2016).

²⁵⁶ Op. Cit. Schröpher, pg. 33.

²⁵⁷ Ibid., pg. 8.

4.2. Materials Selection Regarding Economical Considerations

For a given application, possible materials should be listed according to the required properties, but consideration of the cost is the dominant criterion for final decisions in most cases as noted by Charles and Crane. For example, capitalist economy calculations, which are used in marketing, take the certainty of profit within a foreseeable period into consideration. Therefore, manufacturers should provide a substantial improvement in performance in materials which have more cost than similar ones do. Otherwise, architectural firms would not prefer those costlier materials due to increased increment of cost for the project as a whole.²⁵⁸ This example can also be explained by “cost-effectiveness and value analysis,” which are clarified by Charles and Crane. While value is defined as “the extent to which the appropriate performance criteria are satisfied,” cost is defined as “what has to be paid to achieve a particular level of value.” The consideration of the properties of a given design and material would be relevant to the extent that they are cost-effective. In other words, it is preferable for an architectural firm to dispense from a higher level of “value” to reduce costs.²⁵⁹

In the manner of cost considerations, time management can be regarded as a sub-consideration. For example, delays in completion can be very costly. In terms of materials selection, frequently, many materials would not obtainable within the maximum time permitted for decisions. Therefore, the best available materials would be preferred even it means a loss in the technical advantage. Also, many designers frequently select materials in haste without the use of best possible data, or the benefit of the most up-to-date experience because of time limitations.²⁶⁰

²⁵⁸ Op. Cit., Charles and Crane, pg. 17.

²⁵⁹ Ibid., pg. 18.

²⁶⁰ Ibid., pp. 13-15.

4.2.1. The Influence of Market Economy on Architectural Design Decisions and Materials Selection

“In the past two decades, economic bubbles inflated and architectural spending around the globe reached a fever pitch. In both well-established centers of capital accumulation and far-flung locales heretofore seldom uttered in the same breath as the name of any Pritzker Prize winner, audacious building projects sprang up like mushrooms after a good rain. At the same time, the skyscraper, heretofore more commonly associated with the hurly-burly of American capitalism seemed only a few years ago as if it might pack up and relocate permanently from Chicago and New York and settle instead in Dubai and Shanghai.”²⁶¹

As indicated in the quotation above, Benjamin Flowers explains how architecture has suffered from capitalism which directs the economical fields around the world in the book entitled “Architecture in an Age of Uncertainty.” He says that as a result of capital power struggles and Great Recession, the decline in the employment for architects and the numbers of students preferring to study architecture have been observed. On the other hand, for the firms which are involved in the ‘*starchitect*’²⁶² universe,’ architecture remains profitable. Plenty of super- luxury projects have been generated because of the increasing purchasing power of the wealthy, which has been rooted in recession's paradoxical effect. Economical reasons have come to define architecture while the thinking about materials related to architecture has changed as well.²⁶³

Paradigm shifting experiences such as 9/11, ecological disaster on a growing scale, the explosion of architectural projects over the world, and global recession have characterized the current era as specified by Flowers. Entirely new urban landscapes and a lot of building projects have been spread around the world because of financial

²⁶¹ Benjamin Flowers. *Architecture in an Age of Uncertainty*, edited by Benjamin Flowers. London and New York: Routledge, 2016, pg.1.

²⁶² Benjamin Flowers uses the term ‘*starchitect*’ to criticize the architects who are celebrities with their iconic buildings and paid well although most of their projects have become money-minded. See, *Ibid.*, pp. 2-13.

²⁶³ *Ibid.* pp. 1-2.

speculation and remarkable sums of capital from East and West. According to Flowers, most of these projects, of which architecture he regards as ‘a means rather than an end’ such as in the case of Herzog& de Meuron’s 1111 Lincoln parking garage which was built to guarantee approval for construction of the retail space at the ground level, include non-architectural matter. His citation from an architect who says “It is just a business,” about his projects for wealthy but suspect clients summarizes his discussion about the situation of architecture and profit. Flowers adds that “as the wealthy and powerful grow more so, so too is there an increase in the perceived power of architecture to cloak that wealth and power.”²⁶⁴

According to Karl Marx, as cited by William Mangold, when something can be regarded as a commodity, to exploit it becomes possible. Capitalists become able to generate a profit by making labor power turned into sellable commodities while also payment for the labor has been less than the value of the commodities produced. For Marx, while “use-value” means the real amount of labor put into an item, “exchange-value,” means a subjective amount established through social interaction.²⁶⁵

Mangold mentions that architecture, which has turned into a commodity through capitalism, has been exploited in current milieu of capitalist production and consumption. For example, in both scales of materials and buildings, architecture is commodified through purchase and sale. Therefore, their “use-value” is ignored because of evaluating them with their quantified “exchange-value.”²⁶⁶

The other case which concerns this study and discussed by Mangold is the current tendency of focusing on practical matters instead of debating aesthetics. As noted, the consideration of aesthetic can be regarded as irrelevant, superfluous and a waste

²⁶⁴ “Architecture in an Age of Uncertainty: Tales from the Recent Architectural Past,” in *Ibid.*, pp. 5-11.

²⁶⁵ Karl Marx as cited in William Mangold. “Architecture and the Vicissitudes of Capitalism,” in *Op. Cit.*, Flowers ed., pg. 16.

²⁶⁶ *Ibid.*, pg. 17.

of money because the practical concerns of how people live in places are not really challenged or modified by the design with aesthetical concerns. He adds that buildings are standardized because of the lack of time for research or to develop projects thoroughly. He explains these regulated projects with a quoted term which is “value-engineered”²⁶⁷ that describes “the process capitalists use to extract the most profit from their projects, confronts architects at every step and aptly summarizes the ways in which architecture is exploited.”²⁶⁸

Although there have been exceptions some of which are exemplified in the second chapter of this study, designers have tended to produce the same type of buildings with standard materials, such as the high-rise buildings with glass claddings which are shown in Figure 4.13 and Figure 4.14, as a result of concerns about cost and time. Another example of standardization is given by Margarete Leite who explains that some of the mass-produced modular structures, which are the products of faster and cheaper process than customized design process, make its way to the marketplace which still demands ever-cheaper products with ever-shorter time frames.²⁶⁹

Leite regards modular structures as an advantageous method to provide buildings in the circumstances of current economic struggles; yet, she still questions the possibility of producing a better, greener, more adapted to human needs and more aesthetically appealing product. For her, to create her ideal architectural product, which requires more money and more time, has become almost impossible because of the current model of the economy in the world.²⁷⁰

²⁶⁷ Cliff Moser. “Using Active Value Engineering for Quality Management,” The American Institute of Architects, 2009, as cited in *Ibid.*, pg. 20.

²⁶⁸ *Ibid.*

²⁶⁹ Margarete Leite. “Faster Better Cheaper: Social Process for a Modular Future,” in *Op. Cit.*, Flowers ed., pp. 25-40.

²⁷⁰ *Ibid.*, pg. 31.



Figure 4.13 High-rise buildings in New York City

Source: <http://280madison.com/wp-content/themes/280-madison/images/slides/2.jpg>, (29 June, 2016).



Figure 4.14 High-rise buildings in Dubai

Source: Michael Aynsley. "The World's 10 Tallest Buildings of 2015," *ArchDaily*, 2014, <http://www.archdaily.com/567003/the-world-s-10-tallest-new-buildings-of-2015>, (29 June, 2016).

4.2.2. New Materials Selection Methods in the Age of Consumerism

As told by Charles and Crane, mistakes in an architectural design process such as incorrect calculations about materials' properties or wrong time management can be very costly. With the development of computer-aided design in recent times, the designer has been allowed to use more sophisticated theory in the design process. Therefore, he has become more confident and ready to work closer to the margin of failure.²⁷¹ As mentioned by National Research Council, the most up-to-date information about materials' properties, knowledge of factors such as life-cycle costs, and available materials for a design can be provided by the use of computer-aided systems which can reduce cost and design rework. These systems can also provide archiving of materials selection decisions for future reference through their learning capabilities. Within the cost-performance criteria and particular set of product characteristics, designers can select from an expanded range of possible materials and manufacturing methods which can be ensured by these systems.²⁷²

According to Schröpher, with the developments in computer modeling, complex three-dimensional virtual models have been started to be used by the designers and contractors to conduct business. For example, in many areas of construction, Building Information Modeling has become standard to respond the desires to inhabit buildings in which materials are given back their third dimension. Also, it has become easier to consider the temporal properties of, for example, smart materials, which change their properties under changing conditions, through computer modeling.²⁷³ Schröpher adds that new rapid prototyping and fabrication techniques which have been developed through the advancements in computational design, allow producing customizable products. Custom components have become easier to

²⁷¹ Op. Cit., Charles and Crane, pg. 13.

²⁷² Computer –Aided Materials Selection During Structural Design, Washington, D. C.: National Academy Press, 1995, pg. 1.

²⁷³ Op. Cit., Schröpher, pg. 24.

build with a relatively low cost through digital fabrication tools. As a result of these new techniques, the designer's selection of material has been influenced according to the parameters of computer systems.²⁷⁴

On the other hand, computer-aided design can also be a limitation in terms of integration of formation and materialization. According to the architects Achim Menges and Michael Hensel, the design process should be generated by the material systems. In the architectural design; form, material, and structure should be in complex interrelations. Computer modeling is criticized by them because "the underlying impoverished notion of form generation, which refers to various digitally driven processes resulting in shapes that remain detached from material and construction logics."²⁷⁵

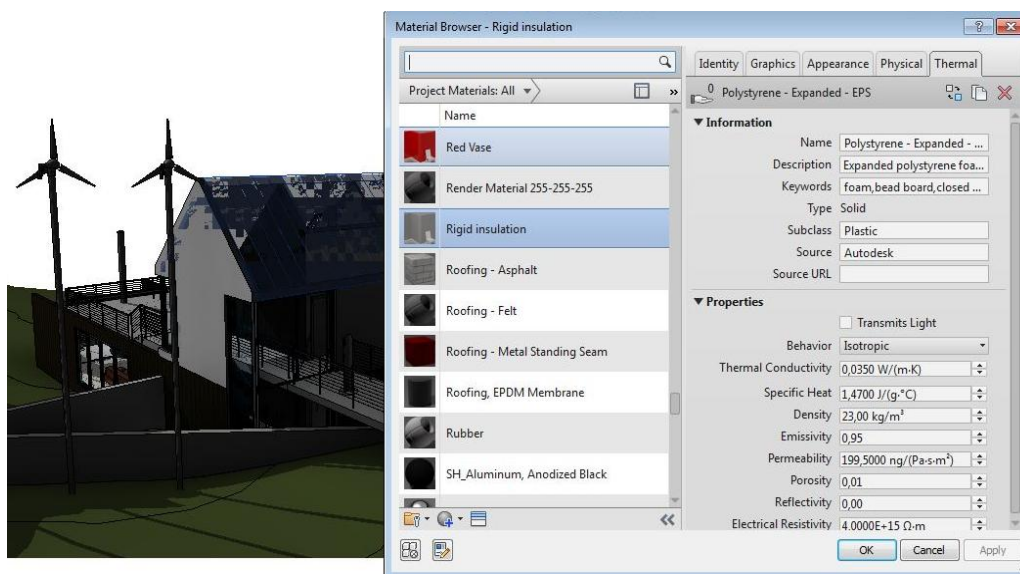


Figure 4.15 Screenshot of three-dimensional model and material browser from Revit Architecture

²⁷⁴ Ibid., pp. 171-178.

²⁷⁵ Achim Menges and Michael Hensel as cited in Ibid., pg. 171.

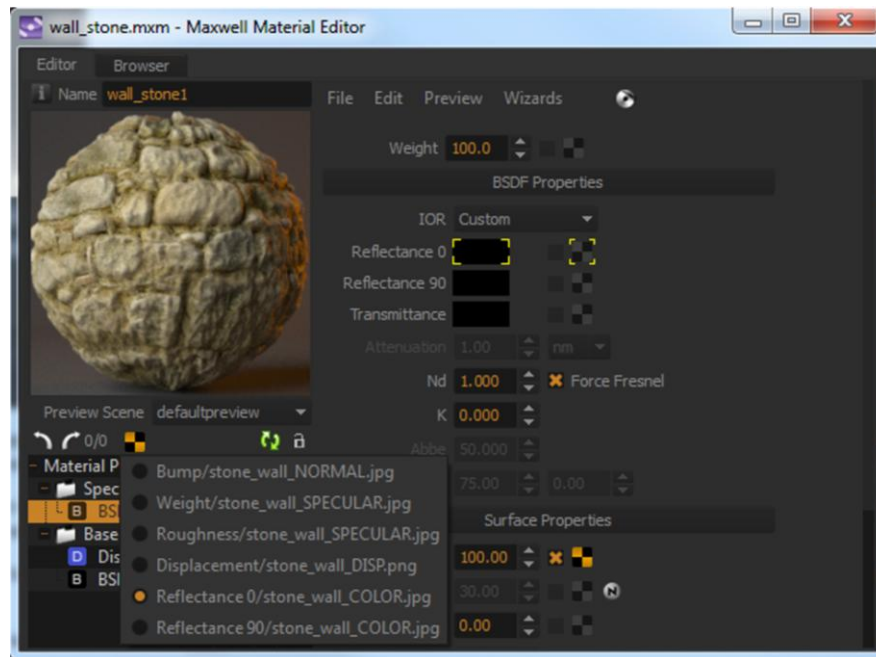


Figure 4.16 Screenshot of material editor from Maya Maxwell

In addition to computational materials selection methods, to have associations with active materials group to consult about materials can be regarded as a fresh way to select proper materials in the design process. According to William Cavanaugh, Gregory Tocci, and Joseph Wilkes, new architectural design teams include many specialists such as foundation, structural, mechanical, electrical, and plumbing engineers. When the design process and building become more involved, consultants are needed to get advice.²⁷⁶ For Inglis, as cited by Charles and Crane, every design office of significant size should be advised by its materials group or external consultants about materials at the possible earliest stage of conception.²⁷⁷ For example, it is feasible to overlook the importance of a specific, precise condition about a particular material because of the complexity of the high-grade applications

²⁷⁶ *Architectural Acoustics: Principles and Practice*, edited by William Cavanaugh, Gregory Tocci and Joseph Wilkes. New Jersey: John Wiley & Sons, Inc., 2010, pg. xi.

²⁷⁷ N. P. Inglis as cited in Op. Cit., Charles and Crane, pg. 13.

with modern materials. In order not to do this, multi-disciplinary design team, of which members can be a group of specialists and even material consultants, should be involved in the design process. In that kind of complex projects, to incorporate with a materials engineer can ensure the remedy at the possible earliest time, for example before any materials and methods would be selected, for the full implications of possible service hazards.²⁷⁸

4.3. Materials Selection Regarding Sustainability and Environmental Sensitivity

As mentioned before, environmental issues regarding materials selection are already present, but they are not the dominant factors in general. On the other hand, they appear to become the ruler of the materials selection as well as the architectural design process as a result of new environmental concepts. According to Charles and Crane, the total energy cost of a material and the ease to recycle it can be considered as two possible additional factors which can have more exceptional importance for materials selection in the future. These two considerations arise out of the concept “Spaceship Earth,” which means the limited resources of the planet. For example, while concrete is a low-energy material, yet not recyclable; titanium is high-energy material that can be recycled uneasily and dearly. Some metals including steels can be recycled with relative ease, and some plastics are recyclable to a measurable extent by current methods.²⁷⁹

In similar with Charles and Crane, Schröpher mentions the issues sustainability, energy efficiency, and material lifecycles in relation to the future’s possible dominant considerations of materials selection and architecture. He says that ‘green movement,’ has affected building industry and materials to an unrivaled extent.²⁸⁰ It

²⁷⁸ Ibid.

²⁷⁹ Op. Cit., Charles and Crane, pg. 7.

²⁸⁰ Op. Cit., Schröpher, pg. 178.

is described in the book entitled “Ideas and Actions in the Green Movement,” as that “radical, political and social changes are necessary to deal with the ecological crisis. These changes would result in a new kind of society, based on a new relationship with the natural world, a more radical democracy, and much greater social equality.”²⁸¹ In an online dictionary which provides directly related definition concerning the production of the building industry, the green movement is defined as “a popular movement urging production and use of environmentally harmless consumer goods.”²⁸²

As a result of increasingly prioritized considerations which are mentioned in the previous paragraphs, some designers use solutions such as rammed earth, radiant floor heating, solar cells, wind quills, blinds and lighting systems through remote-controlled switches, or passive climatization through phase-changing materials which release heat energy by changing their state to reduce energy requirements. Schröpher says that chemistry, biology, and thermodynamics have started to have more remarkable roles than physics has, in order to facilitate comfort levels in the buildings, as a consequence of the increasing utilization of the new technologies.²⁸³

While some architects and clients have pioneered ‘green design,’ regulatory agencies and many governments have started to set up standards to encourage sustainable buildings. Through these standards and certified environmental credentials which include for example Leadership in Energy and Environmental Design (LEED) ranking system of the United States, the impact of buildings on the environment have been rated and ranked. The LEED ratings are based on five classes which are sustainable site development, energy efficiency, indoor environmental quality, water saving and material selection. Other ranking systems include the seal of quality of the German Society for Sustainable Building (DGNB), BRE Environmental

²⁸¹ Brian Doherty. Ideas and Actions in the Green Movement, London and New York: Routledge, 2005, pg. 1.

²⁸² <http://www.thefreedictionary.com/green+movement>, (02 July, 2016).

²⁸³ Op. Cit., Schröpher, pp. 178-179.

Assessment Method in the United Kingdom, the HOE in France, and the Green Star in Australia.²⁸⁴

The use of novel solutions to reduce energy requirements can be cased with the LEED-certified Turkish Contractor's Association Headquarters, which is remarkable because of its environmental design approaches. For example, to utilize diurnal temperature range of the local climate, an underground cooling labyrinth system, which uses thermal mass and optimizes building's environmental performance, is employed. Therefore, the energy demand is reduced to provide comfort in response to changing external temperatures. Its outer skin, which is made of two layers, is considerable as well. While the first layer consists of a frameless glass to glass or glass to metal facade panel system, the second one is produced with stainless steel mesh shading. This screening system provides occupants visual relationship with the outside and gives a response to the solar orientation and exposure to sunlight. Greywater and rainwater recycling, recycling stations, solar panels, solar cells, bicycle racks are some of the other applications in the building.²⁸⁵

This building is also remarkable for its material consciousness. While natural materials including timber and stone are preferred, the use of local materials to minimize environmental impact is paid regard. For example, marble from Kastamonu, which is another Turkish city, is used as an external rain screen cladding system. The rain water drains the facade out through the joints between the stone panels.²⁸⁶

²⁸⁴ Ibid., pg. 180.

²⁸⁵ AVCI Architects as cited in "Turkish Contractor's Association HQ/ AVCI Architects," *ArchDaily*, 2014, <http://www.archdaily.com/503937/turkish-contractor-s-associaton-hq-avci-architects>, (July 04, 2016).

²⁸⁶ Ibid.



Figure 4.17 Turkish Contractor's Association Headquarters
Source: Ibid.



Figure 4.18 External mesh shading of the Turkish Contractor's Association Headquarters
Source: Ibid.

LEED-Certified 1315 Peachtree, which is an adaptive reuse of an existing office structure that was deconstructed, by Perkins+Will Architects is another one of the remarkable examples in the frame of sustainable buildings. The residual materials obtained from the deconstruction were donated to 20 non-profit organizations for reuse with local needs. According to Karissa Rosenfield, while medicinal plants were planted in the civic plaza, remediated and organic soil has been left uncompressed to provide healthy root system for the trees. Other environmentally sensitive applications in this building include natural daylighting, cooling systems which use water rather than air, raised floor systems which provide fresh air ventilation, occupancy sensors, radiant heating/cooling, rooftop energy-recovery wheel, highly efficient equipment, a heat recovery unit, two MicroTurbines which produce electricity. Also, high-performance curtain wall and glazing system which prevent solar heat gain and glare from the west are applied at the 5th-floor atrium. These applications contribute to the energy efficiency of the building. The use of the chlorofluorocarbons, Freon, lithium bromide, or ammonia has been replaced by the use of water as the refrigerant and silica gel as the desiccant for the adsorption chiller. Therefore, the potential for damage to upper-level atmospheric ozone, hazardous material leaks, aggressive corrosion and chemical testing are eliminated.

Regarding material usage, Rosenfield states the use of porous materials which has replaced hardscaping for providing a solution to the region's water issues. Through this system, rainwater is harvested and stored. Then, collected water is used for flush fixtures and landscape irrigation while overflow water is filtered under the plaza to be used for recharging aquifers. Another environmentally sensitive use of materials can be observed from paints and wall graphics to the carpets and the furniture. The toxic substances in the materials and products which are used in the building are reduced to help provide a clean, healthy indoor air quality with the aid of under-floor air distribution.²⁸⁷

²⁸⁷ Karissa Rosenfield. "Exemplar of Sustainable Architecture: 1315 Peachtree/Perkins+Will," ArchDaily, 2012, <http://www.archdaily.com/215002/exemplar-of-sustainable-architecture-1315-peachtree-perkinswill>, (July 6, 2016).



Figure 4.19 1315 Peachtree with plants and organic soil nearby
Source: Ibid.

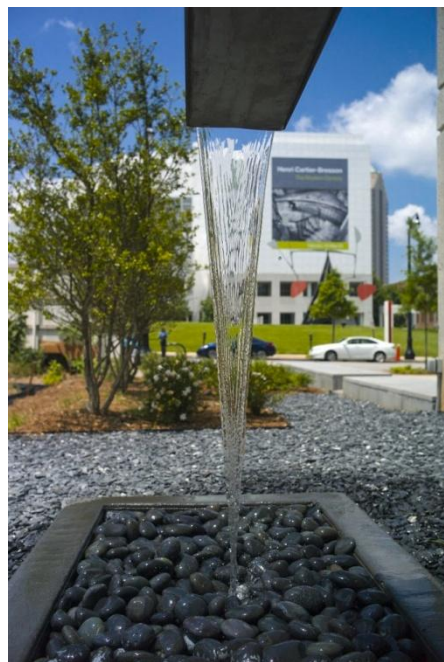


Figure 4.20 (left) Steel trellis and motorized shade system to protect the space from too much sun penetration
Source: Ibid.

Figure 4.21 (right) Use of porous materials for region's water issues
Source: Ibid.

According to Schröpher, the management of the materials during the design process and construction directs the environmental effects of building industry. Therefore, comprehending the nature and history of building materials as well as the new energy harnessing technologies is critical while creating sustainable environments. In this manner, using local and recyclable materials from renewable resources is essential.²⁸⁸

As cited by Schröpher, William McDonough and Michael Braungart clarify that ‘cradle-to-cradle’ lifecycles in the production process may be considered as a solution to the conflict between industrialism and environmentalism. The waste of industries can be used for goods and services by turning the present open-loop industrial system of "take, make, and waste" into a closed circuit.²⁸⁹



Figure 4.22 (left) ICEhouse by William McDonough

Source: Eric Oh. “William McDonough Unveils ICEhouse™, The Next Step in the Circular Economy,” *ArchDaily*, 2016, <http://www.archdaily.com/780655/william-mcdonough-unveils-icehouse-the-next-step-in-the-circular-economy>, (July 6, 2016).

Figure 4.23 (right) Steel structure and exterior cladding of NASA Sustainability Base

Source: William McDonough and Partners, <http://www.mcdonoughpartners.com/projects/nasa-sustainability-base/>, (July 6, 2016).

²⁸⁸ Op. Cit., Schröpher, pg. 180.

²⁸⁹ William McDonough and Michael Braungart as cited in *Ibid.*, pg. 181.

The ICEhouse, which is designed by William McDonough, is an example of cradle-to-cradle design as explained by Eric Oh. This house, which is designed with a simple, structural system, can be built and rebuilt in just a few days. While it can be adapted to local materials, it allows endless reuse and relocation.²⁹⁰ Another example is NASA Sustainability Base, which is designed by McDonough and AECOM. It utilizes a braced frame which reduces the amount of steel in terms of weight. Also, the amount of material required for construction is reduced by using lightweight insulated metal panel cladding. Technical and biological cycles, as well as the recyclability and locality of the materials, are also concerned. For example, the concrete, steel, glass and aluminum in the building have high recycled content and are regionally available. Also, the steel structure of the building enables to dismantle or to repair the structure quickly while pre-fabricated unitized components are used for exterior cladding.²⁹¹

In the context of sustainability and environmental sensitivity, Schröpher continues, architects have started to be interested in biology and chemistry. For example, in Philippe Rahm's Convective Museum and Housing and Studio for Dominique Gonzalez-Foerster the spaces are defined by controlling the air through hot and cold elements, without walls.²⁹² Rahm explains his design idea as follows:

“Today, confronted with the will to economize energy resources, the demand is to set up in each building, and even each room, a precisely calculated thermal capacity in order to expend only the energy that is strictly necessary. Instead of warming all the space at the good temperature around 20°C, we propose to create in the house two sources of heat, like two different thermal poles creating a thermodynamic tension inside the all house: one pole is cold at 15 °C and situated in the upper layers of air of the house. The opposite pole is warm, at 22°C situated in the lower layers of the space. A movement of air will be generated by this difference of temperatures and positions in the space. With the help of thermal model software, we analyze the

²⁹⁰ Op. Cit., Oh.

²⁹¹ “NASA Sustainability Base / William McDonough + Partners and AECOM,” *ArchDaily*, 2012, <http://www.archdaily.com/231211/nasa-sustainability-base-william-mcdonough-partners-and-aecom>, (July 6, 2016).

²⁹² Op. Cit., Schröpher, pg. 181.

variation of temperature and his distribution in all the space and find then places for activities, according to specific temperatures. The project process is thus reversed: an indoor climate is first produced and after, functions are freely chosen anywhere in the space related to the thermal quality required depending on activities, clothes, personal desires. An ecologic and economic gain is obtained at the same time by creating in the whole house a low average of temperature at 18°C instead of the 20°C in a normal heating system.²⁹³

Using natural occurrences, which include wind flows, fluid dynamics, heat flows and such, is a recent interest of many architects to generate new forms in architecture. These developments and the move toward sustainable architecture have new potentials to provide new inspirations and forms in architecture.²⁹⁴ According to discussions and case studies made insofar, it is also possible to say that, this new tendency to be environmentally sensitive in building projects would be dominant requirement for a designer in the future. Therefore, both the architectural design process and materials selection would be based on these new concerns.

²⁹³ Philippe Rahm. <http://www.philipperahm.com/data/projects/interiorgulfstream/>, (July 6, 2016).

²⁹⁴ Op. Cit., Schröpher.

CHAPTER 5

CONCLUSION: THE DECEPTION OF THE CURRENT MATERIAL USAGE

Although the scientific and technological improvements have provided new materials and construction techniques for the building industry, it seems that the transformation of the architectural concerns, which are about formal, structural or functional expressions, in particular by the economical interests has constituted an impediment on 'materiality' in architecture. Also, this alteration in considerations has led the preference of standardization in design which has started mainly in the Industrial Period, instead of the customization of the buildings. Customized design, which is combined with the use of materials' full potential in the building projects, would prosper the building environment. However, the current tendency seems as to design projects without regard to the materials associated with the tectonics, and turning buildings into a 'sign'²⁹⁵ or a commodified 'object.'²⁹⁶

Market economy and commodification of the current period, which have started twenty plus years ago, have favored relegating the "avant-garde" consideration of material as a part of a conceptual project to a technical discourse. Based on this technical discussion, a pedantic history of the building and materials was founded sufficient instead of comprehending the history of architecture fully.²⁹⁷ As a result of

²⁹⁵ Heidegger as cited in Op. Cit., Frampton, pg. 93.

²⁹⁶ See Jean Baudrillard. The System of Objects, translated by James Benedict, London and New York: Verso, 1996.

²⁹⁷ Op. Cit., Borden and Meredith, pg. 2.

increasing commodification of the architectural products, the signs and boards in front of the buildings in Las Vegas as told by Brown, Izenour, and Venturi²⁹⁸, have become the deceptive ‘show-card’ skins to envelope the building in a two-dimensional way around the world.

According to Francesco Proto, when Brown, Izenour, and Venturi mentioned about the facade that is overloaded with commercial signs and detached from the building, it was not as much apparent as today it is. Although they corroborated the expression through signs in architecture, converting a building into a sign was criticized by them. Since then, through the idea of decoration, the architectural organism has been increasingly oversimplified which means that the ideas of Brown, Izenour, and Venturi about the decorated shed has been assimilated all over the world. The enormous and flat facade of the Venturi’s shed turned to be conformed as a prototype for the show of signs and symbols. Therefore, it seems to be superseded the significance attributed to any other feature of the building process.²⁹⁹ According to Scott Brown, with the use of marketing facades, “spectacularisation of architecture,” which can be observed through Gehry’s Guggenheim Museum Bilbao, has been achieved to catch people’s attention to the buildings and bring the people in the cities of which market needs to boom.³⁰⁰ However, as mentioned in the fourth chapter with the case of Guggenheim, creating same buildings in different places coincides with the money interests rather than the essence of architecture.

In addition to the increasing interest in creating current sheds, it should be mentioned that the messages on these existing coverings have been selected by the other people such as clients or contractors, not by the architects in every project. While the ambition to make money has increased, the voice of the designer has started to be

²⁹⁸ Op. Cit., Brown, Izenour, and Venturi.

²⁹⁹ Francesco Proto. “The Old Thing Called Flexibility: An Interview with Robert Brown and Denise Scott Brown,” *Architectural Design: Theoretical Meltdown*, Vol. 79, No. 1, edited by Luigi Prestinenza Puglisi, January-February 2009, Wiley, pp. 70-71.

³⁰⁰ Denise Scott Brown as cited in *Ibid.*, pg. 72.

ignored. Therefore, it has been inevitable to prevent the separation of the spatial concerns of the city and the architectural projects as a result of the globalized gilded world. Also, by regarding the current economic slowdown and new concerns of the current age such as climate change, shortage of water, food, and energy, both architectural products and architects have become a marketing instrument or branding package.³⁰¹ The main reason behind this situation can be considered as the designers' interest for easy recognition which makes their projects resemble each other.³⁰²

The use of digital tools for the sake of spending less time to produce a project as well as to select proper materials with minimized failure within the framework of marketing appears as another director of creating signs in architecture. The increased claims for cost-effectiveness and profit that are combined with the higher level of complexity of the buildings have led architects to rely more on computer-aided design to produce buildings as 'profitable images' in a shorter time.

Producing three-dimensional models and visuals as well as the two-dimensional engineering and architectural drawings in an accurate, speedy and detailed way have been enabled by the computer-aided design. Although drawing sketches on papers manually as a method of problem-solving in the design process has still been valid, computational programs have been treated as the dominant instrument of design once the project has evolved. To make revisions quickly with consistency, clarity, and flexibility and to produce working drawings or to test out the design and enhance it, the digital systems have been heavily counted.³⁰³

Digital information systems seem to facilitate the architectural design process; yet, the drawbacks of them on the architectural projects and buildings should be

³⁰¹ Michele Costanzo. "Twenty Years After Deconstructivism: An Interview with Bernard Tschumi," in *Op. Cit.*, Puglisi ed., pg. 25.

³⁰² Luigi Prestinenza Puglisi in *Ibid.*, pg.10.

³⁰³ *Op. Cit.*, Conway and Roenisch, pg. 109.

eliminated to create sufficient designs regarding the 'spirit' of the architecture. As comprehended heretofore, this study is not intended to propose not to use any computational program while designing a building. However, it should be considered that, although the images and digital models of the buildings may seem to be three-dimensional with realistic material applications on them, the designer is only able to see them on a two-dimensional screen. Therefore, evaluating these models to comprehend how the proposed built form will look like in relation to its surroundings and physical materials that would be used according to the project is still a problem. The interrelation between form, material, and structure in the physical world may be more complex than it appears in the digital media. However, it seems that in order to increase the marketability of the buildings, designers have not considered these interrelations as well as the materiality issues throughout the whole design process including the part when computer aid is involved.

As discussed insofar, since architectural design process and the considerations of the designers have been reshaped as a result of new cultural priorities, increasing expectations of the consumerist society, mass-production and standardization as well as flexible manufacturing processes including digital production, it seems that the features of architecture such as to resist time, to belong a specific context, to give references to a particular period in history, region and culture have been lost. Buildings have become similar 'objects' that are produced through mass-manufacturing all over the world while they have been presented as custom-designed 'models'. As mentioned by Jean Baudrillard, 'objects,' have irrevocable features and parts that provide the function of that object such as the engine of a car. Since people of the current consumerism age demand individualisation of the 'objects,' it is only possible to make alterations in the appearance such as adding accessories to the coachwork of the automobile. Therefore, the demand for the personalization of the objects brings extrinsic additions to the object.³⁰⁴ Since same philosophy has been applied in architecture, the context of architectural identity has been reduced to an external view of the buildings. Accordingly, the association between materials and

³⁰⁴ Op. Cit., Baudrillard, pp. 137-142.

building tectonics has been disregarded while dishonest use of materials has been preferable among the designers to justify the transformation of the buildings into commodified objects. However as mentioned by Borden and Meredith:

“... we are part of the fields of matter, materials are matter, and matter is always connected to all other matter, the notion of negating materiality is no longer ontologically possible. Architects and architecture are part of mutually interdependent material networks composed of neurons, trees, electricity, finance, et cetera, all together. We operate in the context of simultaneous and dynamic forces to which all matter is subject and with which all matter participates, amplifying and mitigating and being amplified or mitigated in turn.”³⁰⁵

Although there has been a shift towards to ‘a more practical model of design’ in which material performance has been taken into consideration, understanding materials as protagonists rather than an assistant to form and appearance has not been still appreciated by most of the architects. This incompetence should be covered to make the built form the ‘thing’ instead of the ‘sign,’ since built form is “a presence rather than something standing for an absence.” Through inventing new methods which would help to constitute “the sense of denaturalized, destabilized, and contingent matter-as-material, matter-as-social, and matter-as-fabrication-technologies,”³⁰⁶ the ‘significance’ of materials should not be underrated anymore.

Therefore, this study criticizes the current situation that shows regarding materials just as the final touch in the design process to decorate the buildings has become a general norm in architectural thinking. To preclude this norm before it triggers architecture to lose its significant status as a discipline, this study claims that actually comprehended notion of ‘materiality’ and to appreciate the significance of materials through by their nature can be functional instruments to prevent the current dissolution of architecture as an object in the built landscape.

³⁰⁵ Op. Cit., Borden and Meredith.

³⁰⁶ Ibid.

Since current system of building industry generally steers architects to subdue materiality in projects, architectural education can be asserted as the crucial step for them to comprehend the significance of materials in architecture. Design courses in company with the materials studies as well as the researches about the materiality in architecture would provide foresight about the effects of materials on design issues both to students and professionals in architecture. Although, it seems that monetary concerns of present employers force designers to make decisions mainly in the frame of 'cost-effectiveness' and to turn buildings into 'commodified objects,' the priority of the architects should still be creating spaces worth to live in for the occupants, not just to exhibit to them. As exemplified through case studies in the first two parts of the third chapter, it is still possible to constitute qualified built forms that would be long-lasting and consistent with the spirit of the architecture by the progressive and contemplator interrelatedness of the materials and the components of the architectural design, especially the building tectonics.

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