

THE INFLUENCE OF TECHNOLOGICAL EVOLUTION OVER THE MUSEUM'S ARCHITECTURAL IMAGE

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Abstract. The appropriation of technological progress is currently one of the touchstones of the architects; the speed of change is obvious around the world. Everything is regarded in a restructured outlook, constantly returning terms as: variability, freedom of expression, simplicity and essentiality of space and equipment, capacity to adapt over time. In theory must be marked the fact that it is evolving towards innovation, which is a constant interrogation of the past and a relentless attempt to anticipate the future. The evolution of the museum architectural expression includes extremely wide range of approaches, from simple construction, from demountable, modest materials up to large buildings, carried out on significant surface, which can bring to the forefront great variety of complex, current forms. It can be noticed the transition of just over one century, from the phase of architectural constraints, imposed by both formal and constructive, to a stage of boundless freedom, materialized to a variety of options. This paper brings together some selected examples of contemporary museums, performed by renowned architects, with comments that emphasize the architectural trends arising from these projects, capturing the plurality of directions and approaches.

Key words: museum architectural program, technology, architectural image, trends

1. Introduction

The actual manner of thinking and designing of a building is changing continuously. It is a fact that today we are building much faster than yesterday. The construction of a new building is a complex and involving process which involves many different people. Architects must fulfill new requirements, must have superior technical and organizational knowledge; all buildings must comply several technical goals, technological and aesthetic corresponding of new criteria: in addition to the traditional economy,

strength and durability, is required efficiency, competitiveness and energy performance.

A single person no longer pretend to possess all these data, which correlated with details to the urban criteria, and management criteria, resulting a new approach: multidisciplinary teams of specialists coordinated by the architect.

1.1. Objectives

The transformation process of contemporary architecture is based on few

certainties, and among these, one is that architecture basely depends to technological progress, to the discovery of new materials and technologies used in construction. Technological architecture starts and changes with technology inputs and the evolution of science in general. It is the result to the requirements of solving practical problems: bigger openings of the interior space lower the total costs of the building, easier maintenance, etc. What is new compared to other studies is precisely the perspective over the designing of the museum spaces according of multi-criteria issues (technological progress, architectural program, architecture image). I have tried to highlight a support for getting the nature of those spaces in future; I do not want to try a limited, exact definition. I consider more important the dimension offered by the monument in time and the dimension of multiple possibilities of configuration that generate specific events.

1.2. Opportunity

„The most complex type of position paper is the academic position paper in which arguments and evidence are presented to support the writer's views” (Sanders, 2005). It is a great opportunity for me, to reflect to some ideas, which appear very often in my professional field: the museums buildings. This paper intended to be a support of documentation for student architects and for anyone wishing to access some innovative ideas, in the time when thinking and designing of a building is constantly changing (Stănculescu, 2012).

2. Evolving towards innovation

2.1. Methodology

My selection emphasizes breadth and diversity, balancing major buildings, some incontestable masterworks, with lesser-known trends and examples. Rather than simply describing it I highlight comparisons

that can be read in multiple ways and seen from different perspectives.

2.2. Designing the museum space

Future predictions about the characteristics of the museum architectural program, must guided to these items: user, technology, environmental issues, architectural expression, trends.

Architecture is able to satisfy more complex human needs, resulting from a lifestyle continuously changing; the architectural programs as an expression of the human also are changing. Buildings or spaces which host these programs should also reflect the change. Flexibility is definitely a modern goal, but like Louis Kahn's concept, architects must design two types of space: for walk and for stay (Zevi, 2000). Translated into the museum architectural program, there are also two types of spaces: great halls or „rotonda” and galleries (Pamfil, 2009).

The museum was to be a genuine institution and not another „ware-house”, was to reflect the changes in the artistic life of time, to assist the public in gaining some direction among the works of art presented to it and avoid leaving it „defence-less” before them. Otto Wagner's Living Art Gallery presents at the beginning of the XX century the slogan of Secession Movement: „should have given that age its art, and art, its freedom” (Călugărița, 2008).

The museum space is essentially an experimental one, in continuous move (Lucaci, 2008). It cannot be preserved in a certain form; it is compelled to make room for other occurrences which may stretch the limits of knowledge. The artists, in their permanent creative restlessness, have continuously experimented with new and unusual media, languages and means of expression.

The space dedicated to contemporary art, is a space where the talent, creativity and intelligence accumulated in almost all areas of human activity, technical performance and modern research come together. It is a place for exhibit productions resulting from the effort of inter-disciplinary teams, where the fantasy of the artist is supported by newest structural ideas.

2.3. About modern technologies

Modern technology makes an important contribution to the level of physical comfort in modern buildings: facilities, air conditioning, use of high technology and informatics in control, surveillance and building management; modern science and technology now enables computerized control of acoustics and sounds, shaping the various possible scenarios.

Future intelligent buildings are programmed to self managed. But also, architecture is a synthesis of rational construction and irrational emotion, percept and passion (Iana, 2012). Technical solutions that reflect the shape of the desired psychological sensations are requested, distributed on perception quality areas.

Some theories suggest that: "regarding the universe, space-time, matter and consciousness will become equal partners in a single supra-reality in a multidimensional hyperspace" (Smythies, 2003).

2.4. About environmental issues

Environmental issues: green design, energy consumption, maintenance costs are now covered from the design stage. New trends and attitudes have emerged in the '80s, as a consequence of the environmental problems such are: material economy, reducing of energy consumption, recycling, increased emphasis on waste problem, etc. Where architecture is heading in terms of this clause? At this point, all areas of human

activities, including the museum space architecture, must take into account long-term consequences of the impact on nature.

The evolution of architectural expression in museum buildings is also following "green" trends. Studying these proposals is underlining the trend of reconsidering the patterns, by proposing appropriate directions of development according to social, economic and technological realities. Everything is viewed in a new, reorganized perspective, always returning the terms such as: development processes, variability, freedom of expression, simplicity and essentiality of space and equipment, reducing investment and operating costs, ability to adapt over time, intensive use of space.

Many architects find themselves by discovering the world, contributing to the wealth and diversity of world's architectural heritage (Accorsi and Lamarre, 2007). Crossing borders opens up unlimited spaces in which to be free in spirit.

2.5. About some new contemporary buildings

The selection of some museum projects show how some great architects have opened up to the world in their designs. These are highly diverse in type and size and also very eclectic in concept and form, eliciting diverse reactions and using multiple references to produce hybrids, sometimes strange and often surprising results.

An overview of contemporary architecture certainly reveals a lot of thinking, a wealth of complex forms that seems to defy an easy classification. After the international architecture of the twentieth century, the dawn of the twenty-first is seeing an explosion of trends, a mixture of styles and urban rules, revealing more individual and yet more international expression.

A new large architectural vocabulary is opened, with elements like: tubes and pipes, connecting walkways, bridges, mobile elements such as elevators, lifts, capsule, cranes, daylight control devices; a world of machines is out of sight - The Pompidou Centre, built in High-Tech style by architects Renzo Piano & Richard Rogers - Paris 1977 is one of the most important building of the XX century (Jodidio, 2006).



Fig. 1. The Pompidou Centre - Paris

Modernism was an international, rectilinear style of glass and concrete that embraced mass-production and had little respect for local traditions; it was supposed to create a new, classless world order by providing a rational architecture that could accommodate everyone.

The architectural image of a building incorporates a wide range of particularly approaches, from simple buildings and modest materials, to a large scale developed surfaces, which can bring to the forefront a wide range of complex current forms and volumes.

The structural design is influenced by construction materials and construction techniques known in a historical period; mutations are created in both: plane and volumetric forms. These types of spaces arise, are maintained, vanish or return to reinterpreted formulas.

Leoh Ming Pei was the winner of the competition for the extension of The Louvre (Jodidio, 2006), one of the world's greatest art galleries and museums. The project propose to freeing up more space to exhibit the museum's vast collections, and to construct an underground entrance lobby beneath the central courtyard, in order to connect the different parts of the building, and to allow much easier public access. The architect's design concept is the reinterpretation of the ancient pyramids, but with modern technologies, built in steel and glass.

The pyramid has a basic structure of steel filled with non-reflective glass (President Francois Mitterand had shown in other buildings he had instigated that he preferred to look into the future rather than mimic the past) (Jodidio, 2006); Pei described this structure as being a light pyramid to represent the living, as opposed to the solid stone Egyptian pyramids, which are memorials to the dead. Over the twenty year period since the pyramid was constructed, it has become one of the most admired feature in the city of Paris.



Fig. 2. The great Pyramid - Giseh, Egypt

It is too simple to suggest there is an obvious progression from Modernism to Postmodernism. Many of the architects covered here are far too individual to be classified at all, but, at the same time, it is possible to identify certain trends and influences.



Fig. 3. The glass Pyramid - Louvre, Paris

Frank Lloyd Wright and Louis Kahn were designing buildings with sculptural forms in the 1950's and 1960's, and, while the buildings themselves are completely different, such diverse architects as Frank Gehry, Daniel Libeskind and Santiago Calatrava can be regarded as having similar aims.

The Solomon R. Guggenheim Museum in New York - named after the philanthropist and art collector whose collection still forms the basis of the museum (Price, 2009), was one of the Frank Lloyd Wright's major buildings, which was finished in 1959. The architect intentionally attempted to provide a contrast to the box-like rectangular towers of New York with his building, making it stand out rather than fit in. The use of what were then innovative building techniques to pour and mould concrete created what is, in essence, a huge sculpture, pointing the way to the future and to the computer-aided designs of spectacular Post-modern buildings.

By the 1980's two new architectural themes were beginning to emerge, High-tech and Postmodernism. High-tech buildings are characterised by their exposed structures, an architecture that celebrates its engineered qualities. Vents and mechanical systems are put proudly on display, and the structural integrity of the building is clear to see. Some argue that medieval cathedrals, with their ranks of slender load-bearing columns and

flying buttresses, are the prototypes of High-tech. Other contemporary practitioners argue that they are simply cranking the industrial aesthetic of modernism up a notch. If architecture was to benefit from mass-production and new technologies, why shouldn't it learn lessons from eminently successful products such as air craft, space capsules and industrial buildings?

Postmodernism was a reaction against the functional aesthetic which had come to dominate the architectural landscape. Architects began to decorate their buildings in an attempt to reverse what they considered to be the alienating effects of Modernism. Classical forms such as the columns and arches began to reappear, even as shallow facades to add interest to what might otherwise be a drab box - what critic William J. Curtis describes scathingly as „skin-deep historicism” (Littlefield, 2002). But opinion is divided over the integrity of Postmodernism. “Decoration can be trivial and tasteless, but it can also give us pleasure, a pleasure which the puritans of the modern movement wished to deny the public” said the art historian Ernst Gombrich in his authoritative work “The Story of Art”, argues that the movement offered light relief from the strait-laced practices of Functionalism. (Littlefield, 2002).

Mario Botta was the Italian-Swiss architect chosen for the project for the Museum of Modern Art in San Francisco - MOMA. Botta designed what he called „a cathedral of art”, producing a highly distinctive building which was completed in 1995 (Price, 2009). The museum has a steel structure which has been clad in brick, a building material Botta has used in many buildings. The galleries of the museum are arranged around the large central space of the courtyard, which gives the interior an open and airy feel, not unlike the plazas of many European cities.

The Guggenheim Museum in Bilbao, by architect Frank Gehry is the best known illustration of the concept of architecture as art object (Price, 2009). It was constructed to attract visitors not only inside the museum, but in the city of Bilbao as well, being part of a strategy to achieve a new image of a city less known worldwide.

At first sight it appears to be an abstract sculpture, whose curving geometrical shapes dash with each other, creating odd angles and elevations. Looked at from the other side of the Nervion River, the shape of a ship, with buildings or mountains rising above it, begins to emerge out of this apparent chaos. These shapes were achieved using computer-aided design and visualisation, fixing the building specifically within a time period defined by the technology available. It is built from three main materials: limestone, titanium and glass. The new material – titanium, which is used in very thin sheets as a cladding, gives the outside shell a highly distinctive appearance by reflecting sunlight. The interior revolves around a central atrium, a huge empty space with glass walls, which, together with skylights in the high sculpted ceiling, let in shafts of daylight, illuminating the interior in the manner of a Gothic cathedral.

If we compare that example with one of Gehry's earlier deconstructivist project: Vitra Design Museum (Zachi, 2008) – builded in Germany in 1989, designed by Gehry Partners, is like comparing David with Goliath. This is not only in terms of dimensions, but in using different materials and shapes. The difference between the technology involved is these two projects is huge, and also the comparison of the building costs.

The media began to track a handful of 'signature' architects, beginning with Frank

Gehry, after he traded the colliding elements in cheap materials of his earlier buildings for sinuous curves in expensive metals (Wright, 2008).



Fig. 4. The Guggenheim Museum – Bilbao



Fig. 5. The VITRA Museum – Germany

The Jewish Museum erected in 2001 in Berlin, is an chaotic zig-zag of zinc-dad steel, described by the architect Daniel Libeskind as forming a compressed and distorted star, a reference to the Star of David and used here to symbolize the connection between Germans and Jews.

The museum is not intended to be a comfortable experience. It is a powerful and moving expression of Jewish history which demands an emotional response. Many of D. Libeskind's relatives were murdered in the Holocaust, giving the project a highly personal aspect (Price, 2009). The single route through the exhibition spaces, crosses the void over a series of bridges, leading visitors through the galleries. The only way of maintaining a

sense of orientation as the path zig-zags is the glimpses of the outside world obtained through the strange angled windows, which appears as slashes on the surface of the museum.

The institution of the British Museum dates back to 1753. Over the years numerous extensions and additions have been added, including, in 1857, the round reading room in the central quadrangle of the building (Powell, 2000). The complex curves of Norman Foster's magnificent roof covering the British Museum's Great Court, for example, were conceived with the help of software used for aircraft design. And the Teflon roof of the Dome weighs less than the air it contains.

Without doubt, the most extraordinary aspect of this project is the tessellated glass roof, which appear to swirl out of the top of the reading-room to cover the entire quadrangle, creating the largest covered square in Europe (Sudjic, 2001).

The roof consists of more than 1,500 glass panes, held in place by a steel structure. Because of the undulating shape of the roof, each of the glass panes needed to be cut to a unique shape, meaning that the completed roof had to be fitted together in a manner of a giant puzzle. It was finished in 2000, and for the first time in 150 years, it is now possible to gain access to all four wings of the museum without having the walk through any of the other wings first (Price, 2009).

Tate Modern, on the other hand, is a contemporary interior within an existing brick structure. The former industrial structures have come in the last decades to represent a real challenge to architects and artists. The reason for this increased interest can be identified in the particular expressive and evocative power that these structures possess, due to a certain feeling of

monumentality given by the ampleness of such halls which defy any reference to the human scale. Designed as Bankside power station by Giles Gilbert Scott in 1948, the building lay unused from 1982 to 2000, when it re-opened as a centre for contemporary art (Littlefield, 2002). Masterminded by Swiss firm Herzog & de Meuron, the aesthetic of the original building was preserved and even the new seven-storey interior structure was given a heavy, industrial treatment. Curiously, the architects chose to locate the main entrance not on the river-front under the chimney but around the corner on the western side of the building. What this does, however, is provide the visitor with a breath-taking view running the entire length of what was once the turbine hall of the power station.

Externally, there are only two predominantly opaque glass volumes that signal the conversion of the power station into a museum. The building has proved to be immensely popular as a tourist attraction and visitor numbers have far exceeded expectations. Avoiding the gesture of erasing the traces history has left behind, this conversion in Modernist style appears as a natural act of assuming the past (Butu, 2008).

Jean Nouvel hardly needs to be presented to those who follow contemporary architecture. He completed in 2006 the most significant new building erected in France in many years, the Museum of non-European Arts and Civilisations, on the Quai Branly in Paris - the banks of the Seine, near the Eiffel Tower. The elevated, reptilian volume underline the fact that Nouvel has broken with almost every convention of contemporary architecture - "given the rather complex articulation of the structures visible in the section, the museum looks different from every angle" (Jododio, 2006). Nouvel took the commentary of residents into account, lifting the museum section off

the ground, allowing plants and pedestrians to cross over, making his rather large building appear to blend into the garden. The same vision had Zaha Hadid in her newest museum project in Rome. The reptilian volume seems to be detached from the ground, liberating an existing land surface for the pedestrian use. The structure which this made possible is a combination between steel and rough concrete.

Santiago Calatrava designed the extension of the Milwaukee Art Museum which opened in 2001. The main building opened in 1957 and was designed by the Finnish-American architect Eero Saarinen. It is the first example of his work to be built in the United States of America and it takes a sculpted Postmodern form. It is constructed from white-painted concrete, but also gives the impression of lightness. The most distinctive feature is the huge brise-soleil (70 meters) which can be opened to control the amount of light and temperature into the entrance hall. Entrance to the museum is via an pedestrian suspension bridge, linking the city to the lakefront. The sculpted exterior of the building also resembles the outline of a ship.

Peter Cook & Colin Fournier (Spacelab) won the competition for Kunsthhaus Graz. The Old Town of Graz was one of the few in central Europe to survive the World War II almost completely intact (has been designated as a UNESCO World Heritage Site). It was a bold choice by the city to opt for the futuristic design drawn up by Cook & Fournier, although, in the light of the Guggenheim Bilbao, the designs of new cultural institutions are now almost expected to be spectacular and daring. Its amorphous organic form was developed with computer-aided design technology. A translucent megastructure of blue acrylic glass appears to float above this, enclosing the exhibition spaces in a skin of light and durable plastic. The roof lights on top give it

the appearance of a bizarre creature, leading it to be called the friendly alien. The hole building becomes a multimedia art installation, like an eccentric sculpture.

The idea for Underwater Archaeological Museum by arch. Jacques Rougerie, won the competition under the auspices of UNESCO. The building of the new museum in Alexandria is linked to the discovery by french archaeologist Franck Goddio of significant traces of the submerged cities of Canopus and Heracleion, and the port of Alexandria, a few kilometres from the Egyptian coast, in the 1990's. The project invites visitors to discover these vestiges in a long walk that takes them from the land under the sea (Accorsi and Lamarre, 2007). From the exhibition rooms in the mainland part of the museum, the route will run down an undersea corridor to a gallery offering a panorama of a reconstituted archaeological dig. Four large curved walls forming a circle will rise above the water to represent this hidden scenography.

3. Discussions

The rise of this new contemporary buildings is partly the result of changing fashions, but it can also be attributed to the availability of constantly advancing technology. Computer-aided design and innovative building techniques, together with the use of new building materials, have allowed architects to experiment in ways that were not previously possible and this has led to the construction of some remarkable and unique buildings.

Technology provides for architects and designers of various specialties freedoms, but also constraints; modern materials, modern design, modern structures. Some specific forms reflect technology, they confess about their construction mode and celebrates the art and the ability to solve contemporary problems.

In theory we must reveal the main two aspects: through conservation and through innovation. Which is an permanent interrogation of the future. These types of intervention are possible: rehabilitation of existing buildings and spaces (Norman Foster's magnificent roof covering the British Museum's Great Court); functional conversion (Tate Modern, the former industrial structures designed by Giles Gilbert Scott in 1948, re-opened as a centre for contemporary masterminded by Swiss firm Herzog & de Meuron); extensions (Santiago Calatrava - Milwaukee Art Museum which opened in 2001); implantation of a new building in a free site (like the newest SANAA project in Kanazawa Japan - 21st Museum of Contemporary Art erected among 2002-04); temporary premises in non-conformist locations (Jodidio, 2007).

In each individual conditions, the concepts of place, site, space, context, regionalism, must be not simply understood, but updated through the study design. „The true nature of architecture is found in the interaction between the architect, the object and the public” (Van Berkel, 2009). Everything is seen in a restructured perspective. Some modes of action are possible in the future: varied architectural appearance at latitude of the architect, based on studies of integration in context; in order to help the architectural image and the concept chosen for the project, by using both light and modulated structures, as well as the heavy classical structures. The image is given to urban areas and may be a trademark of the city, area, street, owner or the function incorporated.

The iconic architecture, it is and will be very close connected with contemporary art, labeling the museum like „cathedral”, starting to opening of Pompidou Centre in 1977 in Paris (Jencks, 2011).

4. Conclusions

Conclusions about architectural trends with implications in thinking and designing the museum building structure.

Through the examples reviewed above, I try to provide an ample image that reveals the directions of contemporary museum building approach and architectural tendencies connected to the structural configuration possibilities (capacity, flexibility, architectural aspect, urban image). Museums have always been sources of pride for the cities (Badea, 2008). They were keepers of treasures which can be analyzed by specialists and admired by the public. They were and still are important buildings and symbols of a city. As keepers of collective values, museums are also symbols of democracy.

We can observe that the transition over a century, from a phase of architectural constraints imposed both formal and constructive, to a phase of an unlimited freedom, embodied in a wide range of possibilities. There is nothing certain about future architecture, but new structures will continue to be both a response to emerging technologies and a nod to the past. Computers were soon omnipresent, catapulting architecture far beyond the previous generation of CAD and computer-aided manufacture. Gehry appropriated technologies from the automotive, naval and aerospace industries, making fluid shapes feasible to build, if economical only in relative terms. Young architects then adapted 3-D modelling programmes from movie special effects and animation to create sinuous surfaces (Wright, 2008).

The museum buildings that emerged in this paper collect the most avant-garde ideas arising from projects, studies and architectural competitions; the study is trying to capture the wealth of ideas that

have succeeded in the twentieth century and early twenty-first century about architectural museum space: continuously reconsidering the models, according to contemporary realities.

New talents will emerge. Some will be daring, their work brilliant and coruscating; others will seek to refine current ideas; an understanding of patterns from the past is a prerequisite for envisaging viable alternatives in architecture, and all the sciences. In that spirit I hope this book encourages readers to look anew at the world around them, past and present, fascinating and disturbing, and thereby to imagine new possibilities.

REFERENCES

- Accorsi F., Lamarre F. (2007), *Exo-architectures* – Ed. of “Pavilion de l’Arsenal”, Paris, pp. 10, 118.
- Badea F. (2008), *Integrating Museums in the Life and Structure of the Cities*, Arhitext **10(188)**:68-73.
- Butu I. (2008), *Provocări*, Arhitext **10(188)**:63.
- Călugărița A. (2008), *Otto Wagner’s Living Art Gallery*, Arhitext **10(188)**:48.
- Iana C. (2012), *The beauty beyond the otherness, (Re)writing history – Abstracts*, Ed. UAUM, Bucharest, pp.241.
- Jencks C. (2011), *The story of Post-Modernism: Five decades of the Ironic, Iconic and Critical in Architecture*, Wiley Academy, Chichester, pp. 204.
- Jodidio P. (2006), *Architecture in France*, Ed. Taschen, Koln, Germany, pp. 110-112.
- Jodidio P. (2007), *Architecture in Japan*, Ed. Taschen, Koln, Germany, pp. 142.
- Littlefield D. (2002), *Modern architecture: London – Carlton Books*, London, pp.18-22.
- Lucaci P. (2008), *Street is my museum*, Arhitext **10(188)**:53.
- Pamfil F. (2009), *The museum space*, doctoral thesis, Universitatea de Arhitectură și Urbanism „Ion Mincu”, Bucharest
- Powell K. (2000), „ *Holding Court*”, Architect’s Journal **212(12)**:24-31.
- Price B. (2009), *Great Modern Buildings*, Canary Press, United Kingdom, pp. 9, 69, 87, 97.
- Sanders M, Tingloo A., Verhulst H. (2005), *Advanced Writing in english: A guide for Dutch Authors*, Coronet Books Inc, pp. 15.
- Smythies J. (2003), *Space, time, consciousness*, Journal of Consciousness Studies, **3**:47-56.
- Stănculescu M. (2012), *Searches, Examples, trends, Challenges with the built environment – 120 years of Higher Education in Architecture*, Ed. Universitara „Ion Mincu”, pp. 322.
- Sudjic D. (2001), *The Monument in the Museum*, Domus, **834(2)**:36-53.
- Van Berkel B. (2009), *UNStudio Architecture&Urbanism A+U* **04(408)**:58.
- Wright G. (2008), *U.S.A. – Modern Architectures in History*, Reaktion Books, London, pp. 235-236.
- Zachi A. (2008), *An Architecture Park*, Arhitext **10(188)**:78-79.
- Zevi B. (2000), *Cadul antidasic*, Paideia, Bucharest, pp. 41.
- <http://www.tate.org.uk/about/who-we-are/history-of-tate/>
- http://www.greatbuildings.com/architects/Eero_Saarin.html
- <http://www.grazcityofdesign.at/en/places/detail/56/kunsthhaus-graz>

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