Identification of the architecture in XXI century “Generation of Legacy Reborn from Innovations”

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Abstract. Scientific discoveries based on innovative materials and technologies of the late XX and early XI centuries are the main sources of innovation in architecture. They made it possible for the architects to widen horizons of creativity and imagine the vision of a future world that was unattainable only a while ago. By studying the technique of “combination” of tradition and innovation in the creative works of Sir N. Forster (Great Britain), an architect with a world renown, and pioneering work of an architect A. Khan (Great Britain) and many others allow to look at the problem of regional identity of architecture under a reassuring vantage point where a blind spot – problems of keeping the identical architecture and its developmental trends – is uncovered in inseparable connection with the globalization processes.

Brief summary. Globalization and regionalization – two phases of world development having an impact on the development of world architecture where the method of “generation” of legacy does not constitute a template since the method of analysis and synthesis of science and art allows for the possibility of the widest range of innovation.

1. Introduction
World globalization is a world of a singular quality which balances multi-vision and multinational and infinitely varied world. At present this is the most discussed problem in the architecture where the issue of the preserving of the identity of cities, countries and nations is very poignant. Subject of the study includes regional architecture, innovative construction materials and technologies, and the object of the study is the trends in the development of regional architecture. The basis of this research is made up of the reviews of publications written by famous architects, practitioners engaged in the field of regional architecture that studied the question of identity as early as in the mid XX century, at a time when modern style was at its earliest stage of development. Factual material for this research is a regional identical architecture represented by the master of architecture in XXI century, Sir N. Foster (Great Britain) on the photos where historical material was used as a “spring board” or as a “combination of traditions and innovations” with the use of innovative construction materials and technical inventions of XXI century.

With the help of Borromean Rings [1] I have connected the philosophy of architecture with science and new technologies into a formula that makes up the center a genuinely new unique product. One of the indispensable conditions was the beauty of the artistic vision which can only exist in specific regional conditions. Principal condition of the research is that the architecture is a project of extrapolation of synthesis of all the sciences, all the arts, synthesis of science and art, synthesis of knowledge and intuition, level of technical progress and other requirements. Architecture, with high
qualities of synthesis, was and will ever be a measure of the level of human civilization and the task of self-identification of countries and nations at the time of globalization; this means preservation of variety in our world.

![Three Rings Merge (author’s image)](image)

**Figure 1.** Three Rings Merge (author’s image)

### 1.1. Aim of the Study

Aim of the study is a search for form, self-identification methods, valuable landmark for the expression of it with the technology provided by the innovative materials. Here it is appropriate to remember the words of S. Giedion, “… the strife for the correct evaluation of global and local conditions of a country considered as a spring board for the creative inspiration” [2]. A. Aalto wrote about national and international in 1967 in his book “Architecture and Humanism” where he predicted the events of XXI “Usually national and international are opposed to each other but it must not be considered that it is the case after all”, “…thanks to their amalgamation the result is reached which combines national and international which means that it corresponds to all the requirement of modern world where these notions are inseparable”[3].

### 2. Khan Shatyr

World famous British architect, Sir N. Foster, used this advice and created one of the most unique and incomparable constructions in the world which is an entertainment center in Astana “Khan Shatyr” (2006-2010 years) its unusual character is as exotic and attractive as a thumb raised by an excited person which has been reminded that this portable tent has finally become stationary.

Did world famous British architect, Sir N. Foster, realize that he had created an exceptionally regional image of nomadic Turkic civilization concentrated in there, close to every Turk object from a distant past: shatyr with a knit canopy and a tripod – Turkic’s invention. Creative image of “Khan Shatyr” turns out to be as if specially ordered ancient Khan tent which we see on the ancient painting of a Japanese artist (Figures 2,3). This is a temporary transportable khan’s tent on a ring supported by the tripod column where khan-chieftain is standing with its warriors with all symbols of worship (Kazakhs, Uzbeks, Turks, Kirgiz and other nations) – Turks: it is a flag with a depiction of a wolf – Turks foremother, “aibalta” – double edged sharp knife in the scabbard of Turkic form, Kazakh-Kirgiz riding suit decorated with the pattern “Koshkar Myuiz” and with possibly many other symbols which ethnographers are more closely familiar with[4].
Figure 2. Kneeling down by the Chinese Prince in front of the Turkic Kagan is happening on the background of the khan’s tent – tent fragment photo 3. [Internet-source]

Figure 3. Part of the picture of the tent with a knit canopy of the thin felted cloth and thick tissue.

Figure 4. General view. Entertainment center Khan Shatyr. Astana (2006-2010) Coating – canopy from ETFE. (architect, Sir N. Foster. Great Britain)

On the picture (Figure 2) an unusual headwear of a Turkic Kagan is depicted with Skif symbols which reveals Skif-Turkic identity and transition of Turkic Culture, ancient Turkics at the cusp of the eras (I century BC – I century AD) invented a saddle, stirrup and full ammunition of a war horse [5].

Shatyr was widely used in the domestic activities for the creation of a shadow in the summer periods and as a shelter in the cold seasons. Shatyr was also set up in summer camps for Khans, warlords and biys.

The result of a combination – synthesis of regional image and scientific achievements is a qualitatively new product of architecture of XXI century – makes a rebirth of a tent of unimaginable height with the capstan of 150 metres that was made possible by modern innovative materials whereas the ordinary tents from the middle ages to present days have been designed for maximum 2-3 people and had a height of no more than 3 metres.

The most impressive part of the construction “Khan-Shatyr” is the tripod column for the dome that was in use by Turkics in their nomadic life and by Kazakh and Kirgiz still setting up dwellings during livestock summer pastures breeding on Jailau. Astana is characterized by prolonged snowy winter periods with low temperatures and high wind activity. For this reason, Sir N. Foster made it his priority to create a special microclimate. Tent upon a tripod with a canopy was more consistent with the local climate conditions and matched the image of the transportable tent which in fact was an insignificant temporary contrivance for the conditions of a nomadic lifestyle.
Figure 5. Main entrance to Khan Shatyr, Astana, Kazakhstan. Khan Shatyr is a cable-stayed building reinforced along the upper and lower rings and a “quilted blanket” is laid along the cable net. The former is a cover made of the innovative material EFTE (2006-2010). (architect, Sir N. Foster. Great Britain)

Figure 6. Tripod column supporting the upper ring of the tent is connect by cables to the lower oval base of the tent. A damper is installed in the upper part of the tripod column, it moves by the wind force to release the snow residue. (architect, Sir N. Foster. Great Britain).

Sir N. Forster made his choice in favour of the tent with intensified cables for which kinetic tripod damper system had been created by M. Cook. The principle behind its operation is the construction of flexible roofing for the release of snow. The giant tripod is a genius cutting-edge constructive decision of the bearing construction of the tent which makes this structure a landmark in the development of national regional architecture of Kazakhstan.

At the stage of installation – elevation of the tripod – Selami Gruel from Turkish construction firm “Sembol” was invited. He had an experience in solving technical problems in engineering. Constructors offered to build and elevate the tripod tower by section with the use of scaffolds, but Selami Gurel offered his idea which was to elevate the tower by single movement – without the crane but with the use of hinge-moving pieces – of two bases of the elevated tower, build the rails for the third base, use high-tech winch – hydraulic industrial jacks. The jacks synchronously elevated the tripod to 50 cm each time for several minutes. It took three full days to elevate the structure and put it in place. This has never been attempted before in practice but it is also true that one has never set a tripod-tower with the height of 145 m without either cranes or scaffolds. This was done by Salemi Gurel who saved time and money. Structures of tripod-tower had been made in Turkey and delivered to Astana in separate pieces which had been connected on the construction site.

3. Pyramid – “Palace of Peace and Reconciliation”

Figure 7. Main façade. Pyramid – “Palace of Peace and Reconciliation” (2004) (architect, Sir N. Foster. Great Britain) (internet source, portfolio of architect Sir N. Foster)
Figure 8. Corner façade. Pyramid – “Palace of Peace and Reconciliation” (2004) (architect, Sir N. Foster. Great Britain) (internet source, portfolio of architect Sir N. Foster)

Figure 9. Interior of the upper part. Pyramid – “Palace of Peace and Reconciliation” (2004) (architect, Sir N. Foster. Great Britain) (internet source, portfolio of architect Sir N. Foster)

Another example illustrates an innovative kinetic invention, the structure used in architecture, which is the Pyramid – “Palace of Peace and Reconciliation”, Astana (2004) (architect, Sir N. Foster, Great Britain). The Pyramid has the following dimensions: length – 62m, width – 62m, height – 62m. This is an equal-sided triangle. Astana has a harsh climate where the temperature varies from the arctic hold to the heat of a desert which constitutes the main difficulty in construction. In the summer the heat reaches above 40 degrees and at night the temperature drops below zero. In 12 hours, temperature variations make 40 degrees. In the winter the steppes are locked in ice and during five months the temperature decreases below 45 degrees. When the wind blows from the Arctic, its speed reaches 200 km in hour and the temperature falls to minus 55 degrees which is one of the most extreme on the planet. According to the engineer of the project George Keliris: “In such conditions it is difficult to build ordinary houses to say nothing about a gigantic pyramid”. In harsh climatic conditions of Astana, the pyramid with the sides of 62 m. was defined by the engineer as gigantic. George Keliris developed the stages of the construction; he laid the foundation of the pyramid in the summer at a time when its upper part – triangle panels – was being constructed in England. The pyramid has a non-standard form for which reason the architect George Keliris was using kinetic supports for almost all the framework of the building. First technical engineering novelty of the Palace of Peace and Reconciliation is that all the building shares the burden between 40 pillars from which only 8 corner pillars are fixed permanently while others are installed on the gliding platforms (Figure 10,11) which can move. The rigidity of eight corners must lead to the rigidity of the apex of the triangle which is why the pyramid getting wider gets lower in summer and higher in winter.

Figure 10.

Figure 11.

Figure 10. Floor plan level zero. (architect, Sir N. Foster. Great Britain)
Figure 11. Column of the pyramid walls on sliding platform structure Astana (2004)

Mobility of 32 out of 40 pillars in all direction is a new engineering solution in the movable steel frame system of the building which provides security to the fencing structures from external temperature variations. It is a bold trailblazing solution which has no analogues in international building practice. The form of the construction and its interplay with the environment are unique which should be a goal of any creative person, Geore Keliris says. He is one of the greatest of contemporary engineers who has invented a new way of building in the extreme conditions which has never been used before.

The apex of the pyramid is a soaring central atrium illuminating the hall of Four Confessions where glass painting is the work of art of the painter Brian Clarke depicting 130 pigeons symbolizing the nationalities inhabiting Kazakhstani soil. On the very top of the Palace of Peace and Reconciliation a hall for 200 seats has been set made in the style of yurt which is a visit card of the nomadic culture [6].
Two small structures built by a British architect, Sir N. Foster, enclosing two edges of the main Government axis of the general outlay of Astana, are Khan Shatyr and Pyramid of Peace and Agreement have become the face of the capital, its metaphoric denominators of the city but also an identity of the city, country, and nation. Could you imagine the innovation should the commissioner have agreed on the initial propositions made by Sir N. Foster where the dimensions of Khan Shatyr and the Pyramid surpass the size of the Pyramid Cheops in Giza [7].

4. “The Window into the Depth of the Universe”

![Figure 12. The Window into the Depth of the Universe”, PyeongChang, South Korea, (2018) (architect A. Khan)](image1)

![Figure 13. Window from the space into the Earth pavilion of water. PyeongChang, South Korea, (2018) (architect A. Khan)](image2)

Innovative materials “focused” on the interplay of the Earth and the Universe in the pavilion “The Darkest Building in the World” (PyeongChang, South Korea, 2018), built in the Olympic village, the commissioner is the firm “Hundai Motor” and “Square Portals” for EXPO 2020 Dubai, UAE (author of the both objects is a British architect A. Khan). He used carbon fibers and Vantablack VBx2 that is even not a construction material because, in fact, it is a kind of paint. British architect Asif Khan made a pavilion “The Darkest Building in the World”. The Pavilion occupies the size of 35 by 35 meters, the height is 10 meters covered by the material “VantablackVBx2” which absorbs 99.96 percent of sunlight making it appear as a black hole for the human eye. Nanotubes are the unique accumulating and transporting systems [8], at the same time hydrogen, which is the most important of the accumulating and transporting agents, is a unique ecological carrier. Hydrogen may solve the problem of city pollution by means of zero emission structures equipped with electric engines powered by hydrogen fuel elements. From afar the façade looks as absolutely flat; but, in fact, it consists of more than million nanotubes with the diameter of around 20 nanometers at the end of which a luminous nano-diode (approximately 3500 times smaller the width of a human hair) with the length from 14 to 40 micron (1micron- 0,001 millimeters). Using the fiber from the nanotubes with the luminous ends is connected to the idea of creating the effect of starlight – a picture of the Universe that we observe from over Galaxy. Approaching the building your attention is captured by the effect of the façade – the darkness of the entrance space, where “cosmos absorbs you – but entering the inside of the building you become blind by the glazed whiteness of the interior made of corian, artificial acryl stone and an installation of water the foundation of life which moves you back to the Earth.

5. “Square Portals”

Next object is “Square Portals” for EXPO-2020-Dubai, UAE is developed by the British studio of architect Asif Khan in the dimensions: height 21 m, length 30 m, material – the thinnest chiselled net of carbon fibre.
The structure presents itself as the mirage of weightless tissue as a thinnest piece of paper that have been made three dimensional form of a square arc, similar to “Arc de la Defence” and the image of famous chiselled Arab machrabiya lattice allowing the passage of air but holding the sun radiation that became the symbol of Arab identity in XXI that was widely used by J. Novel and Z. Hadid in the innovative architecture of Arab countries. Carbon fibre [9] is an extra light and extra strong construction material for the innovations of Asif Khan. Three portals have the same length; they are located on the bridges connecting the roads around the World Fair. Despite their dimensions of 21 m height and 10.5 m width they can be opened by a single person (Figure 15). It took three years for the architects to complete the projects which included a linear park (6 km), recreation zones, water ponds, and green areas. After the fair is over this territory will become a part of the city space. This project includes the construction of nanomaterial designed in a way that the framing is wonderfully feathery as if the portal strives to lift itself into the air.

6. “We are Energy”

Third innovation of A. Khan was the pavilion of Great Britain “We Are Energy” for “EXPO-2017-Astana” – Kazakh yurt from the polycarbonate plates – landmark of energy efficiency, optimization, handy and light, lasting for thousands of years, protecting people from the cold and the heat, and having the same function as a stationary dwelling made of wood, brick or marble, which is still in use in pasture grazing by the people in XXI century. Yurt reacted to the touch with its external coating that represented the screen of eight thousand computers presenting the view [10]. It would take one computer two hundred and fifty years to create such rendering. “This is fully modelled world with its sun, sunrise, wind, and rain” – explains the author of the project Asif Khan.

In the centre of the panorama there is a yurt made of two hundred polycarbonate plates that react to the touch creating light and sound effect. By touching them it is possible to gradually change the

**Figure 14.**
**Figure 15.**
**Figure 16.**
**Figure 17.**

*Figures 14-17. “Square Portals” (architect A. Khan) Nanomaterial XXI century EXPO-2020, Dubai, UAE*

**Figure 18.**
**Figure 19.**

*Figure 18. Yurt “EXPO-2017” Astana. Pavilion Great Britain “We are Energy”*
*Figure 19. Interior of the Yurt “We are Energy”*
weather and time of day on the screens. The touch to the yurt embodies the energy which is a human – this is the theme of the EXPO-2017-Astana.

7. Conclusion
It should be noted that these are not the only unique objects that have been discussed above. Appendix 1 to the article presents several objects that have also been created at the crossroads of the architectural philosophy, new technologies, and kinetic art.

Presented factual material of the research of the first two innovative objects of XXI century may be summarized by the following conclusions:
- specificity of the object under research is its relevance and uniqueness for the country. The first condition for the creating of the innovative building such as Khan Shatyr (2006-2010) and Pyramid the Palace of Peace and Reconciliation (2004) (architect, Sir N. Foster Great Britain) is its great demand: national, political, social and demand of each single individual for the unique identical product related to the history of the people, state, region which made the uniqueness of the commission. Historically their creation was assigned to the most credited authorities in the architecture and construction, the best parts of the city were reserved for their building, the best construction materials were used, the most cutting-edge engineering innovations were employed, special construction technologies were designed;
- at the basis of all five objects of research lie the scientific discoveries in the field of construction materials and living thoughts of an architect, artist, scientist, engineer, builder that could create the face of innovative architecture of XXI century with or without the reference to the historical traditional rots;
- innovative architecture is a product of the technical scientific progress that makes innovations, new buildings that are directed toward the improvement of the people’s living conditions, creation of the artistic image of the architecture relevant to the time, the first innovations would become the identity of those countries, capitals, cities who commissioned them, whose traditions were embodied in their image, such as, for example, Khan Shatyr (2006-2010) (architect, Sir N. Foster);
- wonderful world is born in the creations of Asif Khan, irrespective at the first glance to the urgent problems of humanity where the living tissue is limitless and endlessly small whereas the Universe is endlessly large [12]. Is there anyone who has tried to comprehend the infinity? This sounds insensible banishing all the thoughts on the subject until it is time for the new scientific discoveries; and yet it makes the subject of thought of at least one architect.

Identification of the architecture with the region, state, nation would be impossible represented by the object of architecture under this research unless there were innovative construction materials and technology that allowed for the “generation of legacy” and its rebirth in the innovations of XXI century.

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Appendix 1

| № | Properties of building material | Project name | Architect\ Structural engineer | Location, completion date | Object photo |
|---|---------------------------------|--------------|---------------------------------|---------------------------|--------------|
| 1. | ETFE Ethylene tetrafluoroethylene | US Pavilion at Expo ’67 | Buckminster Fuller, and Golden Metak Productions | Canada, Montreal, 1967 | ![Object photo](image1) |
| 2. | PVC(polyvinylchloride) coated polyester, Silicon coated glass, Teflon coated glass PTFE | Munich Olympic Stadium | Gunter Behnisch Frei Otto | Germany, Munich, 1972 | ![Object photo](image2) |
| 3. | PTFE -coated glass-fiber fabric | KingAbdulaziz international airport – Hajj terminal | SOM | Saudi Arabia, Jeddah, 1981 | ![Object photo](image3) |
| 2. | ETFE | Royal Burgers’ Zoo | Wiegerinck Architects | Netherlands, Arnhem, 1982 | ![Object photo](image4) |
| 3. | PTFE (polytetrafluoroethylene) | King Fahd International Stadium | Ian Fraser, John Roberts & Partners | Saudi Arabia, Riyadh, 1985 | ![Object photo](image5) |
| 4. | PVC coated polyester | Research Laboratory | Philippe Samyn | Italy, Venafro, 1991 | ![Object photo](image6) |
| 5. | PTFE fiberglass | Denver International airport | C.W. Fentrees, J.H.Branburn and Severud Associate/ Horst Berger | USA, Colorado, Denver, 1995 | ![Object photo](image7) |
| 6. | PTFE (polytetrafluoroethylene) | Burj Al Arab Hotel | Tom Wright of WKK Architects and Atkins | UAE, Dubai, 1999 | ![Object photo](image8) |
| 4. | PTFE | Millennium Dome (O2 Arena) | Richard Rogers and BuroHappold Engineering | UK, London, 1999 | ![Object photo](image9) |
| 5. | ETFE | National Grand Theater of China | Paul Andreu | Chine, Beijing, 2000 | ![Object photo](image10) |
| 6. | ETFE | The Eden Project | Sir Nicolas Grimshaw & Partners | UK, Cornwall, 2001 | ![Object photo](image11) |
|   | Material          | Location                                                                 |
|---|-------------------|---------------------------------------------------------------------------|
| 7 | ETFE              | The National Space Centre, Nicholas Grimshaw, UK, Belgrave, Leicester, 2001 |
| 8 | Fiber-reinforced polymer sheet | Natural Ellipse House, Masaki Endoh, Masahirokelda, Japan, Tokio, 2002 |
| 9 | Kinetic system    | The Palace of Peace and Reconciliation, Foster & Partners, Kazakhstan, Nur-Sultan, 2004 |
| 10| ETFE              | The Allianz Arena, Herzog & de Meuron, Germany, Munich, 2005              |
| 11| PTFE              | The Abuja National Velodrome, ASS Architeken, Nigeria, Abuja, 2006       |
| 12| ETFE              | Beijing National Stadium, Herzog & de Meuron, Basel, China, Beijing, 2007 |
| 13| ETFE              | The National Aquatics Centre, CSCEC & Design, Arup Pty. Ltd, PTW Arch., China, Beijing, 2007 |
| 14| The orange-coloured fabric, composed of glass fibre with silicone | The Zenith music hall, Massimiliano and Doriana Fuksas, France, Strasbourg, 2008 |
| 15| ETFE              | Khan Shaty Entertainment Center, Foster & Partners, Kazakhstan, Nur-Sultan, 2010 |
| 16| ETFE              | Lady Hale Building – Uni. of Salford, Broadway Malyan and Buro Happold, UK, Salford, 2010 |
| 17| PTFE              | Al Bahar Towers, Aedas, Arup, UAE, Abu Dhabi, 2012                        |
| 18| ETFE              | The Cuauhtemoc Stadium, Pedro Ramirez Vázquez (1968), Dünn Lightweight Architecture (2015), Mexico, Puebla, 1986, 2015 |
| 19| Polycarbonate plates | UK Pavilion, Asif Khan, Kazakhstan, Nur-Sultan, 2017                     |
| 20| ETFE              | Canary Wharf Crossrail, Foster + Partners, UK, London, 2018              |
| 21| Vantablack VBx2   | Hyundai Motor pavilion, Asif Khan, Unsangdong Architects, South Korea, Pyeong Chang 2018 |
| No. | System | Description | Architect/Company | Location |
|-----|--------|-------------|-------------------|----------|
| 22  | Kinetic system ETFE | The Shed | Diller Scofidio + Renzo, Rockwell Group | United States, New York, 2019 |
| 23  | ETFE | The diablos rojos stadium | FGP Atelier, Taller ADG | Mexico, Mexico City, 2019 |
| 24  | ETFE | The new Yogyakarta International Airport (NYIA) | PT Virama Karya, PT Nur Straits Engineering, PT Penta Rekayasa, PP KSO | Indonesia Yogyakarta, 2020 |
| 25  | Carbon fiber ultra-lightweight | The Expo Entry Portals | Asif Khan, Calin Gologan | UAE, Dubai, 2020 |