STADIUM CONSTRUCTION AND SUSTAINABILITY: THE REVIEW OF MEGA-EVENT STADIUMS (1990-2012)

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ABSTRACT

This paper will try to review the near past of the mega-event stadium construction, and the recent approaches in stadium-building in terms of sustainable urban development and architecture. The research will cover the period of 1990-2012, from the start of sustainability discussions and their revealing implications on stadium-construction up to the forthcoming London 2012 Olympic Games and its stadium. The focus will be on the notions of *flexibility in stadium design* and *post-event maintenance of stadiums for sustainable urban environment*.

Keywords: Mega-event Stadia, Stadium Construction, Sustainability, Olympics, World Football Cup

INTRODUCTION: MEGA-EVENT STADIUMS AND CITIES

Starting from early precedings of Roman arenas, stadiums have always been *significant urban elements* for many reasons- like the extent of the area that they occupy in a city, their size, their function, the spatial relations they motivate…etc. They have a wider *spectacular* dimension comparing to other structures in the city. This is more obvious in the case of the stadiums that are purposely built for hosting a mega-event, like the Olympics or the World Football Cups. They are built with extravagance in order to attract interest of masses, to create a new image about the location they are built in, to launch urban regeneration in their surrounding environment.

Therefore, we come up with a contradiction in stadium construction. On one hand, there is the concern of building a spectacular sports structure as the most important sports venue of the organized global sports event. On the other hand,

this brings about the problem of *gigantism*, which should be discussed within the framework of *sustainability*. A mega-event stadium should seat thousands of people in order to create a festivity atmosphere and it should have a significant architecture in order to remind this atmosphere after the festivity. Moreover, it requires many other services like huge parking areas, supplementary commercial and recreational activities, and well-organized transportation networks for enormous entry and exit movements. However, *the frequency of use* of these structures after the global sports event is also an urban question. Briefly, global-event stadiums should be questioned in terms of *sustainable urban development* and *architecture*, within which the main concern is the effective use of natural and urban resources.

THE CONCEPT OF *SUSTAINABILITY* IN STADIUM CONSTRUCTION

The concept of sustainability can be defined as the condition of meeting the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987). It refers to meet the peoples' *needs* while taking into consideration the *resources* at hand. The resources might be either material, such as fuels or topsoil; they might be social, such as educational levels; or they might be waste-absorbing natural systems, such as wetlands or the atmosphere (AIA & UIA, 1993). Nevertheless, the concept is mostly associated with the natural resources, which refers to environmental sustainability in literature.

There is also a concept of *sustainability in the built environment*, which refers to two important entities. The *first* one is the *sustainable urban development*, which means the efficient use of urban land and infrastructure resources (like water, electricity, heating system, public transportation routes…etc.). Since land is a finite and non-renewable resource, *space-saving approaches* and *energy consuming strategies* should be considered as the basis of sustainability strategies in the built environment. The *second* one is the *sustainable architecture*, creation and responsible management of a healthy built environment on resource efficient and ecological principles (CIB Report, 1999). The principle of *energy-efficiency* is the dominant feature of sustainable architecture, since it directly points to the natural resources - the very essence of the term sustainability. Moreover, the practical aspects such as the choice of materials and waste management are important issues as well as the visual impact of the building and the relationship with its environs, roads or other transport links (Sheard, 2001).

SCOPE OF EVALUATION FOR SUSTAINABILITY IN STADIUM CONSTRUCTION

When we consider a mega-event stadium which is purposely built for hosting a large-scale sports organization and a league stadium, we can see the clear differences in terms of sustainability. *First,* there is a difference in their *use of frequency*. A league stadium is used at least 20-25 times in a year for league matches, and it can also be used for other possible organizations, like concerts. Since the league stadiums are owned mostly by football clubs or municipalities, their exploitation is depended on these autonomous actors. So the issue of multi-functionality is easier in this sense. In a mega-event sports stadium, the owner is mostly the state, which prefers this sports venue to be reserved for international and regional competitions, mostly athletic events. Thus such stadiums are more fragile in terms of their frequency of use. This generates the risk of being worn out in time, which brings about high maintenance costs for the locality. *Second* important difference is the *amount of urban resources* they use. Mega-event stadiums occupy more land. Since their seating capacity is larger than league stadiums, they need more car parking space, more than that; they need additional exercise spaces for athletes of the mega-event. So their impact on using urban resources is more crucial. In this paper, the concept of *sustainability in stadium construction* will be evaluated from this perspective of sustainable urban development and architecture and the scope of the evaluation will be restricted with the mega-event stadium built for Olympics and World Football Cups. In the World Cups, stadiums are the only sports venues of the organization. The main difference between the Olympics and the World Cup is that the former takes place in one host city; while in the latter more than one city of a country host the mega-event. Although the Olympic stadiums will be directly selected for evaluation, selection criteria for the World Cup stadiums will be amongst the ones that are operated by the governmental bodies instead of being transformed to club use after the event.

Sustainability in Stadia from Urban Planning Perspective

The *effective use of urban land* and *urban infrastructure* is of primary consideration in sustainable development. Stadiums are different from other land-uses in the city. A stadium generates flows of people and a variety of spatial interactions over a large area much greater than the stadium itself. It occupies a large urban land while it also requires well-done transport connections to the city, in order to avoid sudden congestions of people and vehicles. As mentioned above, mega-sports event stadiums are more significant regarding the relationship of the city and the stadium. In case of the Olympic Games, the Olympic Stadium is combined with an *Olympic Park* in general, within which other sports infrastructures are installed concerning the efficiency of people's and vehicles' movement during the Games. Therefore, hundreds of hectares are reserved in cities for these

large sports parks. Accordingly, lots of urban services are needed to be established.

The main urban question in that case is the *post-event use* of these areas in favor of inhabitants, who have paid the cost of stadium's and other facilities' construction by their taxes. This must be of a bigger concern in developing economies regarding the limit of their budgets. Cities that are eager to host Olympic Games and countries that wish to host the World Football Cup encounter such a contradiction that they need to develop basic sports needs of inhabitants, while they have to spend large amounts of money to build international-quality and large-scale sports venues. In order to achieve sustainable urban development, the desire of hosting mega-sports events should have a positive turn-over for the local community, which means that the post-event use of stadiums and other sports venues should be clearly planned before hosting the event.

To sum up, sustainable urban development is related with the efficient use of urban resources, within which mega-event-purpose built stadiums should be questioned regarding their post-event turn-over and their physical relation with the city. Otherwise, mega-event host cities would encounter the problem of *white elephants*, which refer to underused facilities that are generally built with public money.

Sustainability in Stadia from Architectural Perspective

From the architectural perspective, we can say that the stadium is the most important architectural element of a mega-sports event. In the Olympic Games, there are many other sports venues besides the stadium. Nevertheless, the Olympic stadium is the central structure in the organization. *First*, the opening and closing ceremonies take place in there. So it is the most significant physical element of the organization to be watched in TV by millions of people all around the world. Thus it should provide an image in spectators' minds in order to recall *that* games take place in *that* city, which is a kind of association of an architectural element with the image (which is most of the time to be newly built) of the host city or country. *Second,* the athletic events – as the most spectacular part of the whole event- are held in this structure. Thus its seating capacity as well as its architecture should be remarkable. Given that the stadiums of mega-events like the Olympics and the World Championships should seat as many as spectators during the sports event, they should be designed with a high concern on flexibility - in order to avoid *white elephants* in host cities.

In order to design and construct architecturally sustainable stadia, some factors covering the life cycle of the stadium should be considered. Consideration should be given to energy-efficiency of the building, searching for the minimization of the demand for energy by Combined Heat and Power (CHP) and/or the energy

potential of the building or site. If possible, the ways of acquiring power from renewable energy sources such as wind, the sea, hydroelectricity and the sun could also be investigated. Moreover the demand for the remaining energy should be fulfilled by the cleanest possible non-renewable fuel (John & Sheard, 2000). Energy usage should be based upon a detailed *load profile* of the venue. This requires that the designers develop a clear understanding between the relationship of base energy loads and peak energy loads, particularly where the venue is multi-purpose. Another factor in terms of sustainability is waste-management, selection of environmental friendly- life time guaranteed-materials, pollution prevention by means of air, noise and light; visual aspect of the design and flexibility of use and potential of adoption to possible future functions.

Proposed Criteria for Evaluating Sustainability in Stadium Construction

In view of this situation described thoroughly above, we should put forward the essential criteria while evaluating sustainability in stadium construction for hosting mega sports events. Paul Henry (2000), the vice president of the Lobb+HOK Sport Architects, suggests four broad strands of sustainability concerning the stadiums:

- *Environmental Sustainability*: It involves how a building relates to its immediate environment as well as its environmental concerns,
- *Physical Sustainability*: The architecture of the building,
- *Social Sustainability*: The people who use that building in the environment,
- *Financial Sustainability*: The entertainment and events within that building to ensure the building remains financially viable.

In accordance with our elaboration of the subject, we suggest the following sustainability criteria in regard to the explanations above while thinking on stadium construction:

- *Physical Relation with The Urban Environment:* how the stadium has effected its surrounding and the city as a whole,
- *Energy-efficiency:* what kind of technologies is used in mega-event stadium construction.
- *Flexibility:* how the stadium is adopted to the needs of the city after the Olympics or the World Cup ends,

  in seating capacity

  in use.

With reference to these criteria, we will try to review the development of the concept of sustainability in mega-event stadium construction, and underline the new design and planning approaches in this field.

A SHORT REVIEW OF THE HISTORY OF STADIA BETWEEN THE PERIOD 1900s - 1990s IN TERMS OF SUSTAINABILITY

Did the concept of sustainability in stadium construction exist before the 1990s? Rod Sheard who is senior principal of HOK+Sport classifies the history of modern stadia in his *five generations* theory (Sheard, 2005b). According to Sheard, modern stadia evolved from two roots: The Greek stadium which is essentially rural and Roman version which is mostly urban form. The *first generation* of stadia dates back to the codification of sport in the second half of the 19th century with the beginning of large attendances to live sport events. They were usually large "bowls" with few amenities. Only in Australia and New Zealand some stadiums were built to be multi-use. One big step was the revitalization of ancient Olympic Games on a larger scale with the first modern Olympics held in 1896 in Athens following the restoration of the ancient stadium to house 70 000 spectators. The stadia that housed the first Olympic Games were unremarkable until the impressive Stade de Colombes in Paris where the 1924 games were staged. The Los Angeles Olympic Stadium -called Coliseum- was built in 1923 with a 76 000 seat-capacity, then the capacity was increased to 101 000 for hosting the 1932 Games. The architecture was a recall of gigantic antique Roman arenas (stades.mythiques.9online.fr/lacoliseum.htm) and the stadium could be seen as a monumental object in the urban landscape which was an antithesis of the grain and texture of the surrounding suburb (Sheard, 2005b).

We can say that the atmosphere of the era brought about gigantic stadiums with huge seating capacities, since the nations were trying to display their power and identity -which had become more visible between the World Wars. One familiar example is the Berlin 1936 Olympic stadium, which seated 100 000 people and planned by Werner March who intended to symbolize "the permanence, indestructibility and political order of the Third Reich" (Sheard, 2005b), and to be used for national demonstrations after the Olympics (The XIth Olympia Berlin - Official Report, 1936). Conversely, the Amsterdam Olympic Games show that there were also understandings on stadiums and their sustainable use after the mega-event. The organizers of the 1928 Games tried to avoid building a huge stadium with permanent seats, and they instead developed a mixture of temporary, semi-permanent and permanent seats in their stadium construction, by which it would be possible to convert the mega-event stadium into more local sporting events. They studied previous stadiums before developing their solution regard-

ing flexible stadium capacity (The IXth Olympiad Amsterdam - Official Report, 1928).

The major shift in the development of stadia happened with the broadcasting of sports events in the late 1950's. There was a sharp decline in the numbers of spectators attending live sport events. The *second generation* of stadia was the response, placing greater emphasis on the comfort of spectators and improving support facilities in the venue. As a peak point of the era, *the Astrodome* in Houston (built in 1965) was the first fully air-conditioned enclosed sports stadium in the world with an artificial turf enabling the multipurpose usage.

Beginning with the 1980s, a process of change has occurred in cities, which has been characterized by entrepreneurialism in urban governance (Harvey, 1989). This was a reflection of the structural transformation from industrial to service-based economy. In parallel with this transformation, a competition has begun among cities for hosting mega-sports events due to their potential to be a stimulus for changing the urban economy (Shoval, 2002). Two important mega-sports organizations in this respect are the Olympics and the World Cups. New stadiums with new architectural expressions have become spatial manifestations of this potential stimulus, since they would create a new image for host cities. One of the most important contributions to multi-functionality in mega-event stadium construction was the Olympic Stadium in Montreal built for 1976 games. The architect Roger Taillibert was asked to conceive a general design capable to integrate the following elements in function: a large 50.000 - seat year round stadium (convertible, at low coast, into a baseball stadium), a swimming center, a veledrome and all related equipments. He designed a 18.000 m² awning of Tolvar, a light, resistant material, to cover the pitch in bad weather conditions, hung to a 168 meter high mast which housed the swimming pool beneath. For the duration of the games, the 50.000 capacity of the stadium was to be increased by 20.000 temporary seats which, after removal, transformed to a baseball stadium. Taillibert drew certain conclusions that enabled him to design buildings that are no longer one-dimensional constructions serving a single purpose and he expressed that "an empty stadium is only a useless and dead monument" (Emery, 1977). The integration of these new equipments into the urban framework of Montreal was also crucial. But in the long term it is proved that the Olympic complex could not regenerate the surrounding environment (Yürekli & Yürekli, 2004). Albeit these attempts, second generation stadia were still largely concrete bowls and a great many of the world's sporting venues remained as second generation stadia until 1990's.

AFTER THE 1990s: DEVELOPMENTS IN SUSTAINABLE STADIUM CONSTRUCTION FOR MEGA-SPORTS EVENTS

Following the *third generation* of stadia characterized by the development in more user-friendly facilities to lure the entire family in the early 1990's, with the integration of funding and management in stadia design introducing corporate sponsorship and the media -which shifted the belief that stadia were a drain on a city's finance- multipurpose *fourth generation* stadia emerged.

Beginning with the early 1990s, the environment has also become a significant issue. The 1992 UN Earth Summit in Rio de Janeiro represented a milestone in addressing sustainable urban development. The publication of Agenda 21 in this meeting composed principles to be applied in this route. The IOC (International Olympic Committee) decided to establish its own Agenda 21 in 1999 in order to promote sustainable development regarding the Olympic venue construction as well (Furrer, 2002). In this report, the IOC underlined that sports-related facilities developed in their name are to be designed to show care and respect for the environment (Sheard, 2001). In parallel to this approach, cities and countries have started to take the infrastructure to be built for mega-sporting events into a deeper consideration. The main tendency has emerged as designing stadiums as all-purpose urban facilities integrated into the city (Metropolis, 2002). It is possible to talk about the Barcelona model in this sense as an urban revolution by 1992 Olympics, which selected sites scattered throughout the metropolis, reinvigorating the entire urban tissue in order to provide the stimulus required for the city to spruce up its public spaces, to clean up its beaches and most importantly, reconnect the city with the sea (Sheard, 2005a).

The *fifth generation* in this theory underlines the potential of stadia as dynamic cells implanted into the urban fabric of a city, stimulating growth and regeneration. Regeneration requires an economic catalyst as well, and in the 1990's it has become apparent that stadia were capable of fulfilling this role (Sheard, 2005b).

Following this general review, we will now try to analyze the post-1990 World Football Cup and Olympic Stadiums concerning the sustainability criteria we set above.

Olympic Stadiums and Sustainability

1996 Atlanta Olympic Games and The Centennial Stadium

After the Lillehammer Winter Olympic Games held in 1994, sustainability has become an inevitable concept in the Olympics. The Atlanta Centennial Stadium was designed on the principle that it is going to be converted to other uses once the event is over. The 85.000 seat venue was converted into a 50.000 seat baseball stadium for a professional sports club in 1997.

2000 Sydney Olympic Games and Stadium Australia

Sydney used the concept of *Sustainable and Green Games* when presenting its bid to the IOC depending on the promise of following the principles of the UN declarations on sustainable development. The most significant feature of the Sydney Olympics is the remediation of an old industrial waste area into a sports park -called Homebush Bay- by using a new technology based on heating to separate waste from soil. The Olympic Stadium, housing 110.000 spectators, the largest in Games history, is located in this 450 ha. park. Its construction started in 1996 and ended in 1999. In spite of all the positive impacts of the Olympic stadium and the park to the site to the surrounding area, it is also stated that the stadium displays a serious problem; attracting large crowds to the newly developed parts of the city away from the CBD. So the challenge of changing people's habits should not be neglected in stadium development (Furrer, 2002).

According to the information given in the official site of the Australian Institute of Energy, the stadium has passive natural ventilation, i.e. ventilation using controlled louvers, large shafts and the natural warmer air, and this has reduced air conditioning demand by 40%. A natural co-generation plant in the stadium reduces main electricity demand by 10%. Large glass surrounded voids and translucent roofing enable sunlight to reach far into the building and reduce the need for artificial lighting, and this lighting system reduces energy requirements by 20%. The rainwater is collected from the roof and stored in four large tanks for irrigation of the pitch, and recycled waters will be used for flushing the toilets. To minimize shadows and patches of direct sunlight on the playing surface, the roof is constructed of 10 m^2 tiles of translucent polycarbonate, separated by stainless steel drainage gutters.

The stadium is planned to host 110.000 people during the Games, and to diminish immediately after the event to 80.000 seats. In order to do that, the stadium was designed with temporary seats at north and south ends which would be replaced by roofed grandstands later. The lower-tier seatings are also movable, so the field can be reconfigured to house soccer or rugby matches (Gilbert & Santilli, 2000).

2004 Athens Olympic Games and The OAKA Stadium

The Olympic Stadium was built in 1982, and it was renovated for the 2004 Olympics. Santiago Calatrava was called to design a new roof structure in order to generate a new image for the stadium and the whole Olympic complex. The stadium seating capacity is fixed, and there are no energy-efficiency approaches available in design of the stadium. The stadium and the Olympic Complex are located in the district of Maroussi, 22 km. north of the city center. The complex was connected to the city center and the airport by public transport networks and

highways. Yet a problem has come out due to the lack of secondary road network which limited the access to this infrastructure (Angelidis, 2002). Thus the newly built infrastructure remained under the level of efficient use. This could be evaluated as unsustainable transportation investment.

It is written in the Olympic Bidbook of Athens that *"the spectacular ultra-modern Olympic Stadium [...] has been designed and built to accommodate a wide range of sporting events"* (Athens 2004 Candidature File). Greece was expecting to host European Football Championship, but they failed in 2008 and also in 2012 bidding. Since there are more and more cities and countries competing to host large-scale sports-events, this kind of statements remain unclear for the future use of the mega-event stadium. Since the government does not allow Athenian football clubs to use this stadium, it is getting worn out while staying unused, and clubs are trying to build their own stadia in the city, which is suffering from open public space. According to many writers, the problem in Athens 2004 Games is that the Olympic project could not be integrated with an urban planning strategy. Instead, it was inserted to the existing master plans (Erten, 2005).

2008 Bejing Olympic Park and Stadium

The theme *Green Olympics* was used by the Beijing Olympics organizers as well (Jin, 2003). The green ring in Beijing's bid was one of the strongest elements in its effort to win the Olympic hosting in 2008 (Furrer, 2002). Sustainable development is the target concerning the post-event use of the venues. An 1135 ha large area was planned for the whole Olympic area (called *the Olympic Green*), within which 114 ha was reserved for the stadium and the close environment. The area is located on the north side of the city, in an area that has been recently subjected to a strong urban growth. It is expected that the new Olympic Green will motivate the creation of a new downtown (Ong, 2004).

Two significant architectural works (The National Stadium and The National Swimming Center) will be constructed in this site. When the Olympics is over, these two symbolic sports structures will be reserved for future international sporting events to be held in Beijing (Ong, 2004). Thus they might create the problem of sustainability concerning their frequency of use.

In the official website of the Beijing Municipal Urban Planning Commission, it is written that the out of the international competition, the project of Herzog & de Meuron was selected for the national Olympic stadium. The spaces in the structure of the stadium will be filled with inflated cushions, which will make the roof completely weatherproof. The rain is collected for rainwater recuperation and the sunlight filters through the translucent roof will provide the lawn with essential UV-radiation. On the façade, the inflated cushions will be mounted on the inside of the structure where necessary, e.g. to provide wind protection. Since all of the

facilities - restaurants, suites, shops and restrooms - are all self-contained units, it is possible to do largely without a solid, enclosed facade. This allows natural ventilation of the stadium which is the most important aspect of the stadium's sustainable design (Official site of the Beijing Municipal Urban Planning Commission).

The stadium capacity is thought as 100.000 for the Olympic Games, while it is to be reduced to 80.000 after the mega-event.

2012 London Olympic Park and the National Stadium

London intends to host the *greenest* games in history, by including "the creation of the largest European urban park [to be the Olympic park], the restoration of the polluted river Lea [a branch of Thames], the clean-up of hundreds of hectares of derelict and contaminated industrial land and green electricity generation for the Olympic Village, as well as energy and water conservation" (Vidal, 2004). The park will be located in the Lower Lea Valley, 13 km east from the center of London. The project is expected to leave the area the legacy of urban regeneration. In the bidbook of London, it is emphasized that the Olympic Park will be open to the whole community, not just elite athletes, which will lead to more opportunities for everyone to participate in sport and physical activity (London 2012 Candidature File, 2004). Nevertheless, the Olympic Stadium is reserved for international and national competitions. It is to be converted into a 25.000 seat multipurpose venue with athletics at its core.

World Cup Stadiums and Sustainability

1990 Italy

For the world cup held in Italy in 1990, two new stadiums were built and the rest 10 stadiums were refurbished. First of these two stadiums is the 60.000 capacity San Nicola Stadium, designed by Renzo Piano as an integral part of a vast park in West Bari which Piano's scheme envisages a sports' city. The area picked for the stadium just outside the city on the road to Altamura, had already been selected under the Master plan drawn up by Ludovico Quaroni in the 70s. The fundamental goal of the project was to create a green area- avertable city park- which would include leisure and non-competitive sports facilities open to the general public. The park itself, in both its function and landscape, would act as a sort of filter between the built up areas and the surrounding countryside. Visual impact of the stadium is reduced to minimum by digging it into an artificial hill. To reach the stadium from parking areas one must cross an intermediate green zone which tends to neutralize the negative effects of the overheated asphalt in the parking places, with considerable influence also on the climatic conditions inside the stadium itself. The tribune is made up of 312 large, pre-cast crescent-shaped elements, assembled on site with concrete casting. The roof covering is resistant,

self-cleaning white teflon which has a characteristics of letting through natural light for the growth of the grass whilst cutting the shadow. The gaps between the prefabricated tribune elements let air flow to the pitch (San Pietro & Vercolloni, 1990). Despite the integral design with the sports city, and the start of Bari football club using the stadium for league matches, the difficulty of maintenance of this outer city stadium emerged in time (UIA, 2005).

The second newly built stadium was the Delle Alpi Stadium in Turin with 72.000 permanent seat capacity. It has been the first privately managed stadium in Italy. A similar approach like in San Nicola is observed in the location and layout at the landscape. A gently-sloping hill, covered in greenery- open to the public every day, given that the exposed structure would act as a perimeter wall when the stadium was not in use. The stadium sits in an urban amenities park which is linked up with city transport system. The park was envisaged as a living botanical garden, incorporating sports, cultural and commercial activities. The project intended to be both the *green lung* of the city and an architectural and landscape filter between the built-up areas of the city and the surrounding countryside (San Pietro & Vercolloni, 1990). Although the quality of the design is satisfactory, both clubs (Juventus and Torino football clubs) announced their desire to move because of the irrelevance of their supporters.

The English stadium expert Simon Inglis comments that in general the Italians have taken enormous risks in the name of structural exhibitionism.

1994 USA

There was already a stock of giant stadiums mostly used for rugby or American football. The facilities adapted to football usage and except the refurbishments in some stadiums not any new venues were built for the World Cup.

1998 France

Stade de France was built in an industrial zone in decline, called Plaine Saint-Denis, has become a venue for culture, entertainment and seminars (Metropolis, 2002). It was the venue for the opening and the final games of the World Cup with 80 000 capacity. Although the stadium mainly caters for football and rugby, the elliptical design also means that it can be adapted for Olympic standard athletics, by the use of mobile first ring of spectators' accomodation, supported by Teflon rollers (John & Sheard, 2000). The stadium has elevated running tracks, which can be installed above the first few rows of seats. The lowest ranges of seats can be projected 15 meters out over the athletics track for non-athletics use. The vision behind the design was to create an atmosphere which discourages aggressive, violent behaviour. The roofs inner annulus is clad in special tinted glass that reduces glare by filtering red and infra red light, while letting through the green

and blue end of the spectrum which is beneficial for both grass and the people (Cathedral of Sport, 1998).

The construction of the parks, gardens and the connections with the surrounding urban areas have failed to live up the expectations in time. The stadium is enclosed by motorways and a canal, completely isolated from its surroundings. The deserted, poorly maintained parking areas, and the out-of-work circus that has struck camp on the route to the metro station, only emphasize the sense of desolation. But it has proven that is certainly not the powerhouse of a new urbanism at is it was announced in the press package of publicists.

2002 Japan-Korea

20 stadiums were planned for the first World Cup hosted by two nations together. Concerning high flexibility and multi-functionality especially in Japanese stadiums, one of them stands out in terms of sustainability issues. The Sapporo Dome designed by Hiroshi Hara is a result of technological innovations in stadium architecture. The stadium is designed to be used for baseball and football (with 43.000 seats). A natural turf pitch is used for football: this is moved into the covered dome from the outside by a *hoover* air-supported system (John & Sheard, 2000). The pitch can also rotate 90º inside the dome and with the help of accordion-like structured seatings, spectators are always close to the action whether the game being played is baseball or football. The adjacent two arenas use the same movable pitch, one open and one under cover. The indoor stadium can be transformed into other types of events (like baseball games, concerts and other uses) in five hours. The only limitation is that the artificial surface for baseball must be installed by hand, and therefore the operation is very expensive. A movable roof was out of question due to the heavy snowfall in such a northern city.

The agricultural land has been transformed into a *sports park* through the organization of homogeneous bands. The ecological approach has made it possible to build a large stadium with minimal environmental impact on the nearby residential and natural zones.

2006 Germany

Germany is ready with 12 high-standard stadiums to host for 2006 World Cup. Of these 12 stadiums 5 are new built and the rest are refurbished. The venue where the final match will be played is the Berlin Olympic stadium built for the 1936 Olympics. The stadium has gone through a big transformation planned by GMP architects. GMP's proposal includes preserving the façade, adding a new roof, providing space for technical rooms in underground level and building a new VIP entrance below ground level with artificial lighting and constructing 630 capacity car park. The stadium reached to a capacity of 74.500 after restoration.

Although it was built for club use as well as being reserved for the World Cup, the Allianz Arena in Munich shows the state of the art in stadium design. Designers of the stadium are Swiss architects Herzog and de Meuron who also planned the 2008 Olympic Stadium of Beijing. It is located in an empty land adjacent to motorway to the airport and close to railway station. The stadium has a capacity of 66.000. The places at the south and north ends are equipped with *Vario* seats, which can be converted into standing space for Bundesliga enlarging the capacity for league matches. Allianz Arena contains mixed zone areas including offices, conference rooms, shopping opportunities and restaurants.

The main innovation in the stadium is the integrated façade and roof covering of transparent ETFE (ethylene tetrafluorethylene) sheeting of 0.2 mm thickness (sb Magazine, 2005). Beneath the roof construction, a partially retractable sun shading system is planned with reflecting and sound absorbing qualities. The thermal separation between the general areas and the heated spaces – for VIP's, offices etc.- is in the form of storey-height double glazing. Openable cushion elements are planned for ventilation and smoke extract. More than 1000 rhomboid inflated cushions on the outer skin are filled with conditioned (dried) air and can adapt automatically to changing loads from wind and other sources by means of a pressure regulation facility. The material is fireproof as well as being self-cleaning. Excluding vandalism, the anticipated maintenance should be very small in comparison with conventional forms of construction (Fuchs, 2002).

2010 South Africa

South Africa experienced the events like Rugby and cricket World Cups as well as Africa Nations Cup in recent past. Therefore we can assume that they have know-how on how to deal with sustainability issues and the legacy of these big events. For the World Cup 2010 South Africa designated 13 stadiums, at least 8 will be used during the World Cup. 3 of these 10 stadiums will be new stadiums being built for the games; another 3 will go on substantial upgrades while the rest 4 will have minimum upgrades. Because most of the stadiums exist, like in USA, the main problem is to prepare them for the event and planning the aftermath, which means planning of the legacy. 3 new stadiums will be built in the capacity of 45.000 each and the planned legacy capacity is 30.000. Also the venues are distributed throughout the country in order to stimulate development in the local areas where the games are played. One interesting example is that the games would help to save the elephants in a planned park between Mozambique and South Africa with the stimulus of the World Cup (Van Vuuren, 2005).

CONCLUSION

Stadium design and construction processes play an important role in the development of architectural and construction practices, since they are large-scale structures and they provide bases for applying new techniques and new approaches in these fields. Nevertheless, their scale and their relation with the urban environment might generate problems regarding sustainability. Mega-event stadia are more fragile in that sense, since their frequency of use is mostly limited to international or national sporting events that are expected to take place in the future. Therefore, it is crucial to build such stadiums within the context of sustainability, which covers not only the energy-efficiency criteria but also the flexibility measures in use and in seating capacity, and the relation with the urban setting. All these must be taken into consideration before the stadium is built.

A very important but easy-to-skip point is that the process of sustainable construction is not independent from the organizing actors, in this article, the IOC and the FIFA. In order to address the requirements of these institutions, locations are obliged to build gigantic stadiums most of which have an unclear future and which consume large amounts of urban resources like transport infrastructure, energy, urban land…etc. Bidding cities of the Olympics and countries of the World Football Cup do not want to fall behind the *competition of mega-sporting event hosting*, which makes the host region a *remarkable place* on the earth. Although these institutions define certain sustainability criteria in their application procedures, they are not enough to get sustainable stadium constructions.

While thinking on the Istanbul Atatürk Stadium that was built specifically for the Olympic bid, it is clear that we should review the project by taking all these discussions into consideration. Its location in the city is fixed, but the physical connections with the city should be clearly set in order that people can access the area in case of a competition. The capacity of the stadium is also fixed for now, but it should be re-studied in order to find a solution. It is known that the football club Galatasaray used the stadium for a while, but it didn't work since the stadium lacked the connections with the rest of Istanbul, the match atmosphere (due to the huge seating-capacity that is difficult to fill), and the wind-protection systems. It might be possible to find our own solutions to our built stadium regarding sustainability.

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