

OLYMPIC STADIUM DESIGN: PAST ACHIEVEMENTS AND FUTURE CHALLENGES

Kiuri, Miranda and Reiter, Sigrid. "Olympic Stadium Design: Past Achievements And Future Challenges." ArchNet-IJAR: International Journal of Architectural Research, vol. 7, issue 2 (2013): 102-117.

Abstract

This article aims to show how the cultural potential of the Olympic stadium can offer new possibilities for its space and its use in relation to the city. The approach considers the UNESCO WCH and the Granada Convention criteria for highlighting three specific aspects of its design: innovation through architecture and technologies; influence on the urban environment; role as a cultural space and as part of a cultural territory. The article helps to better define the cultural heritage significance of those emblematic stadiums.

Keywords: Olympic stadium; innovation; cultural space; architecture of the void.

INTRODUCTION

Historically, the evolution of the Olympic Games (OG) has influenced the stadium design. The first Olympic stadium was the stadium of Olympia. The Olympian stadium was born as result of the OG, its objectives and values, and the stadium's space was culturally significant (Kiuri, 2009; Kiuri & Teller, 2012a; UNESCO, 1989).

After the renaissance of the Olympic Games during the 19th century, stadium architecture changed rapidly during the 20th century. The Olympic Games played an important role in this evolution (Schmidt, 2002). This evolutionary process concerns the stadium design as space, its architecture and its impact on the surroundings. From an architectural point of view, the stadium evolution was primarily driven by construction techniques and materials, but broadened to affect everything connected with performance in sports, standards of play, safety and security, including managing spectator movement and adapting to contemporary means of communication. The stadium's space thereby became an increasingly technical area during its development in the modern era (Kiuri & Teller, 2012a). From an urban planning point of view, the impact of the Olympic Games on the host city has grown. Since 1960, the number of urban areas, infrastructures and facilities included in the Olympic territory's perimeter has increased. This recent period has primarily been characterised by stadiums becoming increasingly sophisticated.

The aims of this paper are to address the design evolution of the Olympic stadium and its relationship with the city at large to better define its cultural heritage significance. This article will study the evolution of the Olympic stadiums and the cultural aspects of the stadium space today. This article aims to show how the cultural potential of the Olympic stadium can offer new possibilities for its space and its use in relation to the city. Our method is based on applying the UNESCO World Cultural Heritage architectural criteria to Olympic stadiums. Studying the cultural criteria for Olympic stadiums, our approach also considers the Granada Convention and the importance of the significance of spaces as culturally meaningful territory in accordance with this Declaration (CE, 1985).

The objective is to highlight three specific aspects of stadium design: innovation through architecture and new technologies, influence on the urban environment, role as a cultural space and as part of a cultural territory. Different points synthesise the applicability of those three Cultural

criteria:

- For the “Innovation through architecture and new technologies” - the human creativity and genius, the advancement of technologies, the outstanding examples (UNESCO, 1972, 2005)
- For the “Influence on the urban environment” - contribution to the urban image, contribution on development of town planning or landscape design (UNESCO, 2005); the dialogue between buildings and spaces (Convention of Granada, CE, 1985)
- For the “Role as a cultural space and as part of a cultural territory” - unique and exceptional testimony to cultural traditions, to specific ideals; outstanding example of culture or human interaction, events of outstanding universal significance; culturally meaningful territory (UNESCO, 2005) (Convention of Granada, CE, 1985)

We present historical paradigms and model examples related to those Cultural criteria. First we will describe the paradigmatic case of the Olympian stadium. The Olympic stadium paradigm is one of the most important lessons regarding the cultural space that is characteristic of the *stadion* (Kiuri & Teller, 2012). We will next present the Olympic architectural model discussed at the beginning of the modern era and the historical evolution of the stadium as a building. After that, we will focus on the recent paradigm born in 1960 when the Olympic Games began to impact cities and their planning; the stadium remains the most important architectural work for the Games.

We will further study this paradigm, considering the period 1960-2012, by analysing the stadiums more deeply following the three research points of view that synthesise UNESCO’s and the Granada Convention’s criteria.

In the final part of the paper, we will examine the difficulties and opportunities that arise when we try to consider the Olympic stadium space as part of the surroundings and the cultural territory. We will open the discussion to a new conceptual paradigm and the new challenges for technological innovation. We intend to suggest a possible reinterpretation of the Olympic stadium “as being part of a city” because the Olympic stadium is a cultural space before being a building. There is a design lesson that can be reinterpreted from the historic Olympic architectural paradigm that might benefit us today.

STATE OF THE ART

A review of the literature related to Olympic stadium architecture revealed that the existing articles focus (1) on their architectural typologies, (2) on the technological solutions applied to stadiums and (3) on the influence of the Olympic stadiums on the urban environment.

First, Sheard (2001) distinguishes 4 generations of stadiums in the modern era according to the level of comfort and safety that they provide. This classification directly focuses on the stadium design itself. By contrast, several authors focus on the progressive emergence of what could be termed “Olympic urban planning” (Essex & Chalkey, 2003; Liao & Pitts, 2006; Kiuri & Teller, 2012a). If most Olympic activities were initially concentrated within the stadium, new facilities have progressively emerged around the stadium in the subsequent editions of the Games. Kiuri and Teller (2012a) propose a six stages typology, starting from the stadium of Olympia during the Hellenistic period, with the focus on the relationship between the Olympic stadium and the city. As Olympic stadiums became increasingly defined as unique “objects” of technical sophistication, they became increasingly isolated from their urban surroundings and they were limited to occasional use (Schmidt, 2002). From the technological point of view, by far the most frequent research topic is the structural system of Olympic stadiums: for example, the structure and construction techniques of the Shanghai Olympic Stadium (Shen et al., 1996), the Athens Olympic Stadium (Biagini et al., 2006), the Beijing 2008 Olympic Games (Liu, 2005) and the Montreal Olympic Stadium (Lazzari et al., 2009) were studied.

Olympic stadiums are continuously evolving to improve sport performance and conditions, as well as improving the comfort and safety of both the athletes and the spectators (Zhang et al., 2007). These requirements will typically impact the viewing angles from the seats to the playing field, the safety escape routes, the facilities for the athletes and, more generally, the number and

nature of the functions hosted in the stadium (Nixdorf, 2008). The multifunctional stadium is a solution that appeared with the Sydney Olympic Stadium and their post event activities (Sheard, 2001). Now, design flexibility is increasingly viewed as a way to address the operational costs of Olympic sites (Martinson, 2009). This need for flexibility has also involved introducing mobile elements (retractable roofs, etc.) in stadia architecture. Sustainable design appears to be one of the next challenges for Olympic architecture, even if some stadiums have already tried to achieve good performance in this area. The Sydney Olympic Stadium in Australia was subjected to a life-cycle assessment with the aim of minimising the overall environmental impact of the development (Myer & Chaffee, 1997).

Regarding the influence of Olympic stadia on the urban environment, stadium architecture for large sporting events leads to buildings that are designed on a scale that is not always in harmony with their immediate environment (Sklair, 2006), cutting the spectator off from both nature and neighbourhood architecture (Kupfer, 1990). In contrast, Yuen (2008) argues that with globalisation, sport development is increasingly being regarded as a part of the city's cultural and leisure capital to reinforce place promotion and consumption-based economic development. The literature discusses the beneficial effect of hosting a major sporting event of global importance, such as the Olympic Games (Hill, 1996; Cochrane et al., 1996; Vegara, 2005). However, the hosting of mega sports events also generates substantial development costs (Tyrrell and Johnston, 2001), logistical problems and security incidents.

The experience of successful urban landscape transformations such as Barcelona's Olympics project model (Garcia-Ramon, 2000; Marshall, 2000; Balibrea, 2001) indicates that a double focus on both competitive projects (for example, innovative design projects) and their concentration in one urban area (e.g., a central declined area) may intensify the positive effects in urban economic regeneration and may upgrade the city's image to an international level (Beriatos and Gospodini, 2004).

This literature review shows that the Olympic stadium has always been a symbol of innovation and that its impact on urban regeneration and new infrastructure development is important. Olympic stadium design can thus help us, through innovations and a renewed vision of the stadium's relationship with the city, to develop a sustainable society that is respectful of its natural and cultural resources as well as its territory.

THE GAMES AND THE OLYMPIC STADIUM: PARADIGMS AND MODEL

The Antiquity: The paradigm of cultural space

The message left by antiquity concerning the Olympian stadium consists of the permeability between the stadium space and the built environment through the visual composition and dialogical architecture. "Olympia is directly and tangibly associated with the games, an event of universal significance" (UNESCO, 1989). The rhetorician Isocrate highlighted the tradition of creating a place in which to reassemble people at the occasion of the 100th Olympiad (Chamoux, 1977). The design of the stadium, part of the Classical period and the Hellenistic Age, is determined by the willingness to reflect the culture's values and to be a place for meeting people and for remembering (Kiuri et al., 2009). The Games define the space of the stadium, assigning to it specific characteristics.

In its historical development, the stadium of Olympia became independent relative to the sanctuary for functional reasons and because of its progressive secularisation, but it remained linked to the site of the sanctuary through the dialogical language of architecture: composition, perspectives, built and natural elements, routes and perceptions. Thus, this characteristic of linkage to the sanctuary provides an identity for the stadium space and defines the paradigm of the cultural identity of the stadium space.

While paying homage to its religious origins and responding to the increasing technical demands of sport and the popularity of the Games, the space of the stadium of Olympia dialogues with its environment, highlighting specific functional (sport) points within the stadium. The space

was conceived of for the Olympic event and the sport area is symbolically configured to provide an identity for the entire stadium. The built environment (the Sanctuary) is present in the stadium through the scenographic effect of its monumental silhouette. This effect can be appreciated at a key location, that is, from the starting line of the racecourse (the *dromos*) or from the last section of the course before the finish, and it lends distinction to the entire space of the stadium by adding significance (Figure 1). At the same time, the stadium belongs to a real location (Kiuri & Teller, 2012b). The Olympic stadium is tangibly expressing the synthesis between culture and nature.

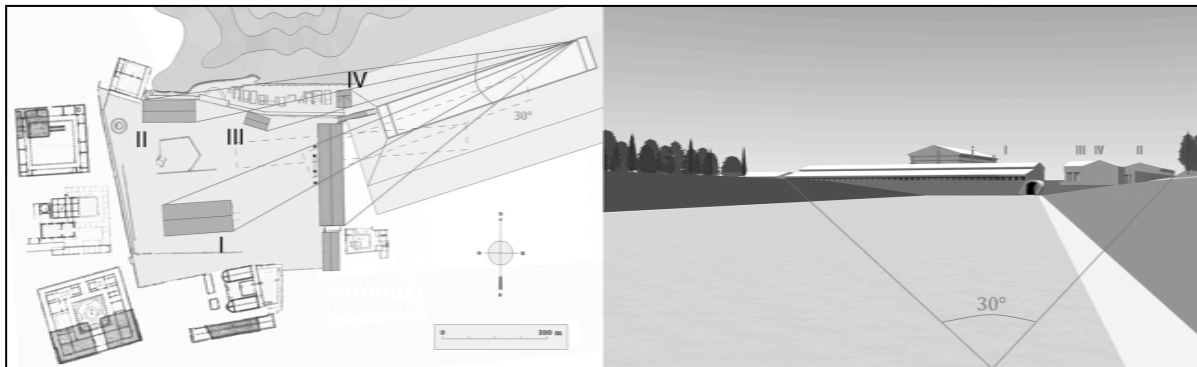


Figure 1: The Olympian stadium, Hellenistic period. View from the track start line
(Source: Miranda Kiuri, Jacques Teller).

The Modern era: a discussion of the Olympic architecture model

“With the renaissance of the Olympic Games as an international event, Pierre de Coubertin, the founder of the International Olympic Committee (IOC), inflamed the Olympic fire. This triggered massive construction work on an international level and investments for the first time in stadiums” (Schmidt, 2002, p.23). The 1896 Olympic Stadium opened a new chapter in stadium architecture. The discussions of a model and the definition of an ideal stadium for a “cultic crown” accompany this period (van Winkel, 2000).

This period also provides the first description of a modern Olympia (IOC 1910): “Une Olympie moderne”. This document highlights the importance of the cultural dimension. The study summarises the ideal model of Olympic architecture through the following concepts: a dignified complex; reflection of the sport-art binomial; landscape harmony; unique place; a masterpiece inspired by an ideal and “Olympic style” construction for posterity. These buildings must be permanent. It is important to give the architecture of the OG other uses after the event.

Throughout the twentieth century, Olympic stadiums have undergone a remarkable evolution related to technological advances. “Architects had to cope with new requirements of international competitions. New solutions have been developed in respect of functional as well as of constructive aspects” (Schmidt, 2002). In 1908, the first modern multisport stadium already showcased bleachers on top of a metal structure. For the first time, roofs were built on the long side of the tribunes. In Stockholm in 1912, the stadium is an example of Swedish national “romanticism” (Schmidt, 2002). The Olympic Stadium of Paris, for the OG in 1924, is a steel-concrete construction. Bricks have covered the façade in the case of the Olympic Stadium of Amsterdam, 1928.

In 1932, Los Angeles constructed the stadium *Coliseum*. One of the trends at that time was to look for the monumental nature of the stadium. The Berlin Stadium, used for the Olympic Games in 1936, was the first stadium located in a 131 hectare park (Schmidt, 2002). The visible steel-concrete construction of the Wembley Park Stadium in London for the OG in 1948 made the stadium a trendsetter in the field of stadium construction. Its two iconic towers became familiar landmarks on the skyline of northwest London (Velluet, 2012). The architecture and construction of

the Olympic stadium for the Games of the XV Olympiad in Helsinki, 1952, originally built for the OG in 1940, were an example of avant-garde Functionalism. "The whole construction formed a continuous system expressing a beauty of tensions" (Kairamo, 1999, p.9).

The recent period: the urban impact paradigm

Already in 1946 in his book "Manière de penser l'Urbanisme", Le Corbusier discussed the "unit of leisure" and listed the Games in first place among other "apparatuses of urbanism" (Le Corbusier 1946, p. 73). In 1960, the paradigm of the Olympics as a catalyst of urban development was born. The stadium complex became a part of the urban landscape and a point of reference.

The impact of the Rome OG on the city was considerable. The Olympic constructions pushed the development of the city toward new undeveloped areas. Rome selected an urban plan based on a two centre model: in the north, a characteristic location in the city, between *Monte Mario* and *La Farnesina*, and to the south, the EUR centre (Rome's World Fair), where there was an extensive green space. In addition, between the two areas, an important public road was constructed: the Olympic Road. For the 17th OG, the search for exclusive and unforgettable images imposed new cultural requirements. The accepted Olympic "model" was adapted to the particularities of the city and its urban morphology. And so, the Olympic Games began to play an important role as a catalyst for urban development, fomenting city growth, promoting existing culture.

The representatives for the National Italian Olympic Committee (CONI) together with the representatives from the Ministry of Public Works prepared the concept of the Olympic Games and collaborated with the state telecommunications agencies (OOC 1963). This collaboration is an example of the scale and planned impact of the Olympic Games. The priorities were the selection of municipal and public land, functionality, low costs and, except for the emblematic location of some of the facilities, the use of existing facilities in addition to the use during and after the OG of public facilities. These subjects are currently the foundation of all sustainable approaches. After the Olympics, the CONI issued an important conclusion: "I once the Games were over, the venues that had been prepared for the event today become an ever-increasing attraction to Roman youth which frequent them with great enthusiasm, filled with the memories of the success of the Rome Olympiad" (OCOG 1963, p.54). It is worth highlighting that the Games were created from the outset with Roman culture and history in mind, allowing for the creation of a wider vision for the setting. Undoubtedly, the presence of television and the search for powerful and unusual images for retransmission further extended the influence of the occasion. The 1960 OG definitely expanded the lively dialogue between the Games and the city.

In the '60s, technology began to play an important role in architectural design. As security measures for the public, the regulations evolved and stadiums predominated where the spectator "places" were replaced with seats, which then made it necessary to modify the seating capacity of many of the stadiums, definitely creating a new "atmosphere". In the most recently built Olympic stadiums, the number of seats has begun to decline. In addition to these changes, post-event flexibility was planned to obtain an installation on a scale that is much closer to human; an example is the conception of the Olympic stadium being built in London for the 2012 Olympic Games.

The OG impact on cities defines a new paradigm that will mark the stadium's evolution. From now on, the Olympic stadium architecture meets the highest technical standards for the practice, the security and the viewing of the sports events. In addition, throughout the years to follow, the stadium will play a special role in the city. The stadium's space is important as a setting for sporting records and events with a socio-historical or symbolic charge.

THE STUDY OF THE OLYMPIC STADIUMS SINCE 1960

A detailed study of the characteristics of contemporary Olympic stadiums begins in 1960 because the paradigm of the Games as a catalyst for the urban development of a city was born at the 20th Olympic Games in Rome in 1960. We examine the years between 1960-2012 to study the Olympic stadiums following the three research points of view, which synthesise the applicability of the

cultural heritage criteria to Olympic stadiums:

- Innovation through architecture and new technologies,
- Influence on the urban environment,
- Role as a cultural space and part of a cultural territory.

The most recent stadium, London 2012, is included in our list, but it should be noted that the official London Olympic report of the Organising Committee for the Olympic Games is not yet available.!

Innovation in the heart of the design and construction process

Olympic stadiums represent not only an example of Olympic and sports history but also an advance from a worldwide architectural perspective. This conclusion was drawn by the work group “*Sport and Leisure*” from the International Association of Architects in 1972 (IOC 1972). In the tables below (Tables 1, 2 and 3), we present the creative work and/or the advancement of architecture and technology for the Olympic stadiums from 1960 to 2012.

The fourteen last Olympic stadiums are thus examples of conceptual architectural advancement and/or technological innovations in various fields: structure and construction technology (Rome, Munich, Montreal, Seoul, Athens, Beijing); comfort (Mexico, Tokyo); illumination (Tokyo); maintenance (Mexico); safety (Mexico, Beijing); sustainability: energy and water (Sydney); materials rationalisation (Los Angeles, London); use of recycled materials (London); reuse of an existing stadium (Los Angeles); historical façade renovation (Barcelona); multi-functionality of the stadium building (Sydney); flexible design: the roofs (Montreal), the stands (Moscow), and the shape (Atlanta; London); and information technology (Beijing).



Figure 2: Beijing Olympic Stadium construction (2006)
(Source: Miranda Kiuri).

Table 1. Olympic stadiums innovations in architecture and technology from 1960 to 1976 (Source: Authors).

Date	City	Innovations in stadium architecture and technologies	References
1960	Rome	<ul style="list-style-type: none"> - Offered an important advance in the use of prefabricated structural elements (almost 100%). - Used steel-concrete construction on 3 levels covered with Travertine. 	Olympic report, p.57 (OCOG 1963) ; IOC Archives: Olympic Games 1960 Kiuri, 2007
1964	Tokyo	<ul style="list-style-type: none"> - Innovated the illumination. - Developed greater height for the suspended construction elements. - Created an important challenge for architects: to create emblematic facilities for the city. - Offered more practical system of entrances. 	Olympic report, p.51, pp. 119-120 (OCOG 1964); IOC Archives, Olympic Games 1964; Kiuri, 2007
1968	Mexico City	<ul style="list-style-type: none"> - Combined symbols of modernity and local values in search of a national architecture with its own identity: volcanic crater concept. - Provided references for Mexico City. - Marked the "arrival of the tartan". - Synthetic resin revolutionised athletic performance and contributed to a very different look for stadiums, changing the maintenance requirements of the tracks. 	Olympic report, p. 108 (OCOG 1969); IOC Archives, Olympic Games 1968
1972	Munich	<ul style="list-style-type: none"> - Constructed with a translucent cover in acrylic glass: an advancement of architectural ideas worldwide. - Changed the nature of the cover by using suspended structures and new materials: this Stadium is a prime example. - Used the concept of "molded landscape" architecture. 	Olympic report, p.18, pp. 33-39, pp. 44-46 (OCOG 1972); IOC Archives, Olympic Games 1972
1976	Montreal	<ul style="list-style-type: none"> - Established the prototype of "a mono volume stadium". - Included the tallest inclined tower in the world: 168m - Used reinforced concrete to its fullest potential (12,000 prefabricated elements). - Used a retractable roof with mechanical system and synthetic textile: 18,000 square meters of parachute silk that could open or close in 20 minutes. - Innovative lighting arrangement featuring a ring composed of 1,146 2000-watt lamps. 	Olympic report p.49, p.51, pp. 52-58 (OCOG 1978); IOC Archives, Olympic Games 1976

Table 2. Olympic stadiums innovations in architecture and technology from 1980 to 1996 (Source: Authors).

Date	City	Innovations in stadium architecture and technologies	References
1980	Moscow	<ul style="list-style-type: none"> - Renovated and modernised for the XXII Olympics steel-concrete construction covered with sandstone. - An innovative landmark solution: the flexibility of the stands for the Olympic swimming pool. 	Olympic report p. 47, pp. 119-120 (OCOG 1981) IOC Archives, Olympic Games 1980
1984	Los Angeles	<ul style="list-style-type: none"> - Represents the only stadium to have hosted the Olympic Games twice, in 1932 and 1984; implies the benefit of the non-use of many materials that would have been needed if a new Olympic stadium was built. 	Olympic report (OCOG 1985)
1988	Seoul	<ul style="list-style-type: none"> - Inspired the design elements with modern international progressive and sculptural solutions mixed with Korean traditions. - Represented a "rare undertaking": the 80 outer pillars were each different in height, section, and curve. 	Olympic report, p.162, p.159 (OCOG 1988); IOC Archives, Olympic Games 1988
1992	Barcelona	<ul style="list-style-type: none"> - Provided an example of a remodelled stadium: the stadium, long in disrepair, was reconstructed for the OG, rescuing only its historic façade. 	Olympic report p.161, pp. 64-65 (OCOG 1992); IOC Archives Olympic Games 1992
1996	Atlanta	<ul style="list-style-type: none"> - Offered flexible design: the concepts of the ephemeral and transformable dominated Olympic architecture. - Moved the nonparallel seating section of the stands farther from the Olympic stadium's field of play than the seats on the east and west sides of the stadium. Created a designated location for photographers in this future home plate area. One benefit was that the constant movement of the photographers did not interrupt the spectator lines of sight from the stands. 	Olympic report p.117, pp. 119-120 (OCOG 1997); IOC Archives Olympic Games 1994; Jakimovska 2007

Table 3. Olympic stadiums innovations in architecture and technology from 2000 to 2012 (Source: Authors).

Date	City	Innovations in stadium architecture and technologies	References
2000	Sydney	<ul style="list-style-type: none"> - Represented a multifunctional concept. - Provided an example of environmental design including a passive ventilation system and a rain - water re-use system (collected from the huge roof areas, it can then be stored and used for watering the pitch). - Used 30% less energy and 20% less drinking water than a stadium with similar characteristics. - Performed an LCA (life cycle analysis). 	<p>Olympic report p.60, pp. 119-120 (OCOG 2001);</p> <p>IOC Archives, Olympic Games 2000;</p> <p>Myer & Chaffee 1997</p>
2004	Athens (OAKA, Spiros Luis)	<ul style="list-style-type: none"> - Included the cover, which is the biggest roof that has ever been built over an already constructed building. (Two impressive arches, each one 304 metres in length, with a bluish tone and transparent polycarbonate iron coating). - Used innovative technology: the additives in the transparent polycarbonates are protection against heat (only light can penetrate it). 	<p>Olympic report, p.157, pp. 171-175 (OCOG 2005);</p> <p>IOC Archives, Olympic Games 2004</p>
2008	Beijing	<ul style="list-style-type: none"> - Included a double translucent roof. - Offered innovation in information technology. - Improved safety and spectator evacuation: a spectator will not need more than five minutes to find his place during a sporting event held in this stadium. Eight minutes are sufficient to disperse the 91,000 spectators. - Provided state-of-the-art acoustics: Membrane material ETFE (ethylene-tetrafluoroethylene) provided perfect acoustic insulation 	<p>Olympic report (OCOG 2011);</p> <p>Official website OG 2008 ;</p> <p>Zhang et al. 2007;</p> <p>Can et al. 2011</p>
2012	London	<ul style="list-style-type: none"> - Provided a good example of materials rationalisation: it uses approximately a third of the steel used in the stadium of Beijing. - Used recycled materials. - Offered a new concept: service areas outside of the stadium shape. - Created a flexible shape, mainly in the vertical axis of the stadium. - Possessed a lower carbon footprint than any stadium that has ever been built for OG. 	<p>IUA, 2012;</p> <p>Official website OG 2012;</p> <p>Averley 2012</p>

Design influence on the urban environment

In the tables below (Table 4 and 5), we present the important influence of the Olympic stadiums from 1960 to 2012 on their cities. The same references have been used for this second study of the fourteen last Olympic stadiums.

Olympics stadiums (the most important construction for the OG) generate new urban dynamics: new transport infrastructures, the creation or protection of green areas, and the regeneration of deteriorated areas. Eleven of the last fourteen stadium complexes and parks are popular locations for public life and have led to the creation of important public transport infrastructure, which are a factor in development and proof of the public nature of these locations. Seven of these stadiums have generated new urban green areas and three of them (Rome, Mexico and Barcelona) have protected significant existing green areas. Eventually, Olympic stadiums also help to regenerate deteriorated urban areas (Seoul, Sydney, London) and to promote archaeological restoration (Athens).

Table 4: Olympic stadiums influence on the cities from 1960 to 1980 (Source: Authors).

Date	City	Olympic stadium's influence on the city
1960	Rome	<ul style="list-style-type: none"> - The stadium complex has protected the green area of Monte Mario for over 40 years. - A public transport infrastructure was developed between the 3 Olympic sites.
1964	Tokyo	<ul style="list-style-type: none"> - The stadium is linked to the Temple, thanks to its clear central axes of composition. There is a clear connection between these spaces that mutually creates a diverse area for public use. - The stadium is a bridge between two parks and strengthens the green area. - The development of the public transport infrastructure was proposed as a concrete objective for the city that was beyond the requirements of the Games themselves. For this construction project, US \$2.7 billion was spent in Tokyo. An example of this project was the construction of 73 new kilometres of metro and the <i>Tokyo-Kyoto-Osaka</i> train. Only 3% of the budget was earmarked for sports facilities.
1968	Mexico City	<ul style="list-style-type: none"> - The university campus and the Biodiversity Park were developed; both were declared World Cultural Heritage sites in 2007 (UNESCO). - Public transport infrastructures were developed.
1972	Munich	<ul style="list-style-type: none"> - The 3 square kilometres Olympic Park is the most popular spot for Munich locals. The embankments that modulate the park landscape are, in reality, the buried debris from the Second World War. - The project created green spaces within a 280 hectares park. In the park, approximately 2.2 m3 of earth were moved for the creation of green spaces. The trees selected serve to design and differentiate routes: lime trees line pedestrian walks; poplars and ash trees line the roads. - A public transport infrastructure for short distances was developed.
1976	Montreal	<ul style="list-style-type: none"> - The stadium is not situated in the centre; it is part of a park that has a botanical garden as a tourist attraction. The Olympic Park was developed in an area that was previously designated for sport and leisure on the outskirts of the city. - As a result, 20 kilometres of metro infrastructure was constructed. - The IOC did not accept the urban planning approach that was presented, suitable from the city's perspective and its growth, because it did not fulfil this Olympic requirement. - As a consequence, the location was changed, and two enormous towers were erected as an Olympic Village, provoking many protests.
1980	Moscow	<ul style="list-style-type: none"> - The Olympic complex is situated in a privileged part of the city in terms of scenery, nature and in relation to important landmarks. - The park is situated in an area of 180 hectares, of which 70% is a green belt area, and contains 30,000 plant species. - The finishing touches were placed on a rationalist plan with different functional areas that began during the 1950s. - The Stadium dominates the composition of the city in relation to other emblematic locations. - The transport infrastructure, roads, telecommunications and the promotion of a hotel network were also developed.

Table 5: Olympic stadiums influence on the cities from 1984 to 2012 (Source: Authors).

Date	City	Olympic stadium's influence on the city
1984	Los Angeles	<ul style="list-style-type: none"> - The Olympic stadium has a strong symmetrical composition; it is situated in a park. Furthermore, it was the biggest Olympic stadium ever created.
1988	Seoul	<ul style="list-style-type: none"> - The stadium regenerated a deteriorated area that was vulnerable to flooding, had poorly constructed homes, shantytowns and environmental problems. - The Environmental Beautification Programme, an overarching city programme, was undertaken to promote the development of public transport and infrastructure.
1992	Barcelona	<ul style="list-style-type: none"> - Situated in a privileged area (the lungs of the city, on a mountain close to the sea), the Olympic stadium is part of an area of natural landscape and is often referred to as "the city's balcony" or even "The Acropolis of the city". - Public transport infrastructures were developed.
1996	Atlanta	<ul style="list-style-type: none"> - An 8.5 hectares Olympic Park was created close to the city's downtown.
2000	Sydney	<ul style="list-style-type: none"> - The stadium is situated in a park covering 420 hectares. - The aim was to use the facilities as a catalyst for environmental recovery in a deteriorated area: 200,000 trees and 135,000 bushes were planted. These efforts resulted in the creation of a reserve covering 50 hectares. - New transport infrastructure was created to support the games.
2004	Athens (Sp. Luis)	<ul style="list-style-type: none"> - The stadium is one of the 16 renovated venues in the city (An archaeological restoration was also undertaken). - The stadium is part of a new urban ensemble. - A metro system was constructed.
2008	Beijing	<ul style="list-style-type: none"> - A new urban park was created: the stadium is the main construction of this site. - The metro network more than doubled in size and capacity with the construction of three new lines with a total length of 200 km that provided direct access to the airport.
2012	London	<ul style="list-style-type: none"> - The Stadium is situated in the Olympic park, a recuperated and transformed an urban area: the Park is viewed as a new London destination that is full of economic vitality (Averley, 2012). - New transport infrastructures were developed.

The role of the stadium as a cultural space and part of a cultural territory

Moreover, modern Olympic stadium spaces have been the scene of important contests and events with socio-historic and symbolic meaning and of events resulting in a long list of sporting records, demonstrating the signs of popularity.

The Olympic stadium of Mexico 1968 is a good example: the principles of modern urbanism and architecture were widely applied in its general conception but were mixed with references to local tradition, especially as related to pre-Hispanic urban architectural ensembles. The Plastic Integration, were incorporated into its design (UNAM, 2005). This stadium had been the location of important sport performances, symbolical social events and human rights protests (Kiuri, 2007).

Today, Olympic stadiums influence not only the groups affiliated with the world of sports but also all citizens. Stadium space, as a place holding living memories, covers a special role that is associated with a special event and ceremonies. They always had an historical role, containing authenticity and uniqueness as a representative example of culture. An Olympic stadium space thus has to be evaluated as a culturally meaningful territory. The main idea behind the design of the Olympic stadium for Munich in 1972 was to harmonise the space with the surrounding scenery (Figure 3). The historic façade of the Olympic Stadium of Barcelona and its historic doors give us other example of dialogue with the city (Figure 4).



Figure 3: Munich 1972 Olympic Stadium and surroundings
(Source: Loïc Hamoir, Liege).



Figure 4: Barcelona Olympic Stadium's urban atmosphere
(Source: Miranda Kiuri).

Ten of the stadiums from 1960 to 2012 provided the spectators with a view of natural or symbolic urban elements. This form of dialogue with the environment is endemic to exceptional public landmarks. However, seven of these stadiums have been significantly modified after the Games and thereby lost this visual connection (Kiuri & Teller, 2012). Stadiums become increasingly sophisticated but its space is isolated from the environment.

Historically, the Olympic stadium space was part of a cultural territory, as mentioned earlier. The Olympic stadium architecture could be a good example of the expression of the contemporary culture–nature dualism, when the visitor is visually connected with the outside world while being physically disconnected from it (Owen, 2008). The good integration of emblematic sport facilities with surroundings, can contribute to increase the attractiveness of the city zones (Ahlfeld & Maennig, 2010). However the visual composition of the Olympian stadium is not applied today. Recently, the Olympic stadium has been considered as a building more than as a cultural space and part of a cultural territory.

NEW ARCHITECTURAL PARADIGM AND FUTURE CHALLENGES

How could the Olympic stadium highlight its space design and create significance in the urban context? Our position is that one of the future challenges for Olympic stadium design is to create a typology that integrates the cultural qualities of the historical paradigms and today’s technical requirements to generate a sustainable future because stadium has a long-term impact on the city. A stadium space that is connected with the urban space could permit uses before and after the sporting events. We will explore the position of the 100 m athletic track as an element of the space design and connection with surroundings. It is known, the 100 m athletic track is one of the most attractive area of the stadium space. Analysing the stadium configuration, this part of the track is like the *dromos* of Antiquity, but this athlete’s route is not integrated as an architectonic element of design (Figure 5). We can observe how the axes of composition seem formalistic from the point of view of the functional role of the 100 m athletic track (the *dromos*) in the stadium (Figure 6).

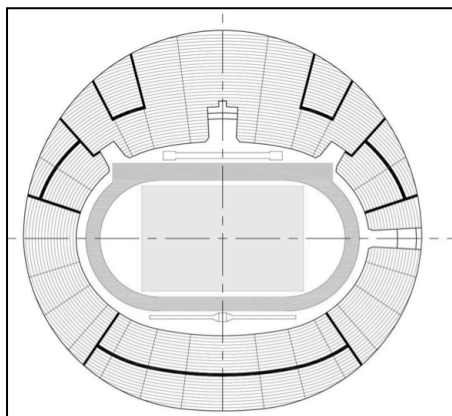


Figure 5: The *dromos* in the stadium of today
(Source: E.V.Arounova, Durban).



Figure 6: View of the *dromos* in the stadium of today
(Source: Miranda Kiuri).

The dialogue between the stadium and the city is not fully explored.

If we put the *dromos* of the stadium in the track of the modern sport arena, the result could be a “sta-ar” (stadium + arena) or “stadar” type of stadium, i.e., the architectural union of the cultural values of the Olympian Stadium with the technical performances of the modern Olympic arena (Figure 7). The visual axes could substitute or complete the geometrical axes in the stadium space.

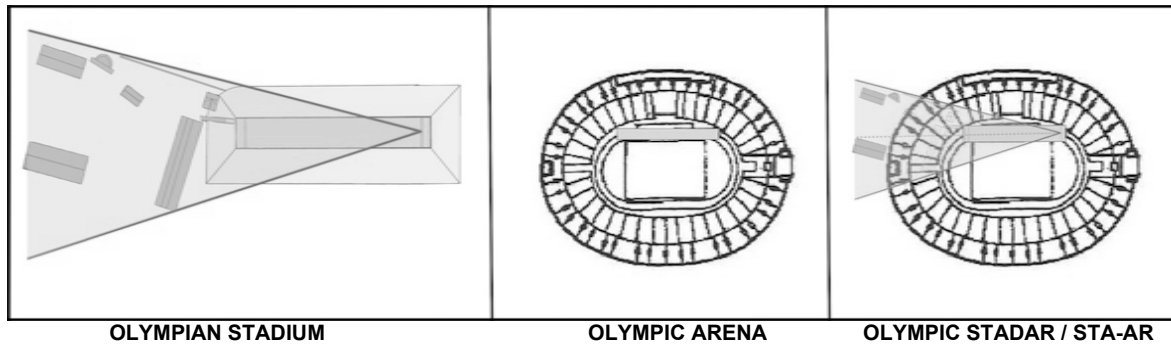


Figure 7: The *dromos* and the stadium (Source: Miranda Kiuri).

So it is possible to enrich the stadium space and make it a culturally significant territory thanks to the urban integration of the *dromos* and the presence of significant urban elements that will provide an identity for the stadium space. The consideration of the stadium as a mere building could be avoided and instead new technical solutions could be developed that meet the demands of comfort, security, adaptability, multi-functionality and sustainability as well as the needs of the context and the representation of cultural values.

A new paradigm could be to integrate the first historical paradigm (the visual composition in the stadium); the message of the Modern Stadium Model (the need for a cultural dimension of the stadium); the second paradigm (the urban impact of the stadium and the need of the cultural territory); the technological requirements of the contemporary period, allowing for more comfortable, safe, sustainable, flexible and multifunctional spaces.

Following Aouad and his colleagues, “innovation benefits can best be achieved through the effort to invest in new ideas and convert them into systematic ways” (Aouad et al., 2010). This new paradigm for Olympic stadiums based on a fusion between the historical values and actual needs and between the cultural values and technological performance should give birth to the Olympic stadium of the future, which will meet today’s requirements and tomorrow’s challenges.

The main difficulties to overcome if we want to open the stadium up towards the city (visually and/or physically) involve security, control and the use of the sport space. An optimal number of seats must be provided, and they must be located in the areas that will provide attendees with the best view possible. The mixed use of the main field is problematic for management purposes and for the maintenance of the field and equipment. Climate-related comfort, especially the wind factor, can interact with the stadium’s openness. One must not ignore the risks and costs connected with all forms of innovation. All changes could require multidisciplinary studies, new techniques, and an adaptation of the requirements. However, the issues presented in this article show the interest in considering the possibility of implementing a new paradigm for the Olympic stadium: the “stadar”.

CONCLUSION

This paper discussed the Olympic stadium’s architectural design achievements and future challenges. First, a literature review showed that the Olympic stadium is a symbol of innovation and a driver for urban regeneration. Then, applying the Cultural Heritage Criteria from UNESCO and the Granada Convention to Olympic stadiums, three specific aspects of the Olympic stadiums’ design were highlighted: (1) innovation through architecture and new technologies, (2) the influence on the urban environment, (3) its potential role as a cultural space and part of a cultural territory.

This article focussed the stadium cultural significance presenting the historical paradigms and the modern era model of the Olympic stadiums. It analysed in detail the characteristics of the fourteen Olympic stadiums that have been built since 1960. Stadiums are the principal Olympic facilities. The stadiums’ architecture meets the highest technical standards for the practice and viewing of the sporting events.

The results show that the Olympic stadium is a technological catalyst that contributes to the

conceptual advancement of the history of outstanding sports facilities. The stadium is also an element of significant urban composition. It has an influence on the city, and it can thus be used as an instrument from an urban planning perspective. Olympic stadiums influence not only the groups affiliated with the world of sports but also all citizens. Stadium space is culturally attractive with historic and symbolic charge but it is not fully integrated in surroundings as part of a culturally significant territory. The principal cause is the requirements for high-quality sports and TV spectacle, the good solutions to security problems all of these are easiest to obtain in a close arena-type stadium. The consequences are that, recently, the Olympic stadium became a formalistic building relatively to its functions. The dialogue between the stadium space and the city is not fully explored. This isolation of the stadium space limits organic approach in creating culturally significant territory.

The dialogue with the environment is endemic to exceptional public landmarks, inherited from antiquity, when the Olympian stadium was conceived in a compatible way with the values of the OG. When they are designed and integrated with their surroundings in an urban concept, the Olympic stadiums can contribute to an increase in the attractiveness of the city zones. We showed how technology and innovation offered high performance solutions for the sport spectacle itself, for security and for creating iconic “objects”. This technological capacity and the innovative spirit could help in the future in the recuperation of the essence of the stadium space and its inherited characteristics. We argued that it should be possible and profitable to reintroduce the cultural role of the stadium through the design of its space as architecture of the void while reconnecting it to its surroundings. The result will permit an attractive design that harmoniously links cultural values and technological innovations and interacts with the city. Some future challenges in Olympic stadium design could be to overcome the security problems and the functional and cost problems that are related to the creation of this new stadium paradigm.

Technical innovations can be used to generate future solutions for these important socio-cultural spaces with active urban role. The proposed new paradigm is more coherent with the multi-functional needs of today, and it links the stadium to its historical development. The aims of this paper are to address the design evolution of the Olympic stadium and its relationship with the city at large to better define its cultural heritage significance.

REFERENCES

- Ahlfeld, G. & Maennig, W. 2010. Stadium Architecture and Urban Development from the Perspective of Urban Economics. *International Journal of Urban and Regional Research*, 34, pp. 629–646.
- Aouad, G., Ozorhon, B. & Abbott, C. 2010. Facilitating innovation in construction. *Construction Innovation*. Vol. 10 (4), pp. 378- 394.
- Averley, J. 2012. “Olympic Legacies”, In: Sporting Heritage, Gemma Abercrombie (ed). *Conservation bulletin* 68: 34-36.
- Balibrea, MP. 2001. Urbanism, culture and the post-industrial city: challenging the ‘Barcelona model’. *Journal of Spanish Cultural Studies* 2(2), 187–210.
- Biagini P., Borri C., Majowiecki M., Orlando M., Procino L., 2006. BLWT tests and design loads on the roof of the new Olympic stadium in Piraeus (Athens, Greece). *Journal of Wind Engineering and Industrial Aerodynamics* 94: 293–307.
- Beriatos E., Gospodini A., 2004. “Glocalising” urban landscapes: Athens and the 2004 Olympics. *Cities*, Vol. 21, No. 3, p. 187–202.
- Can H., Lu M., Gan L., 2011. The Research on Application of Information Technology in Sports Stadiums. *Physics Procedia* 22: 604-609.
- CE (Council of Europe) 1985. Convention of Granada. European Treaty Series No.121.
- Chamoux, Fr. 1977. *La civilisation grecque. (The Greek civilization)*. Arthand, Paris, 476 p.

- Cochrane, A, Peck, J and Tickell, A. 1996. Manchester plays games: exploring the local politics of globalisation. *Urban Studies* 33(8), 1319–1336.
- Essex, S. & Chalkey, B., 2003. Urban transformation from hosting the Olympic Games . [online article]. Barcelona: Centre d'Estudis Olímpics (UAB).
- Garcia-Ramon, MD. 2000. Pre-Olympic and post-Olympic Barcelona, a 'model' for urban regeneration today? *Environment and Planning A* 32, 1331–1334.
- Hill, C R. 1996. *Olympic Politics*. Manchester University Press, Manchester.
- IOC, 1910. "Une Olympie moderne" (A modern Olympia), in: *Cahier des charges pour le Concours International d'Architecture*. La Revue Olympique N°50, Paris.
- IOC, 1926. Olympic Studies Centre Historical Archives. Kentish, J.R, Letter. "*PV Réunion de Lisbonne, Commission du CIO pour les Terrains des jeux*". Lausanne.
- IOC, 1960 – 2004. IOC Archives. Olympic Museum, Lausanne.
- Jakimovska G. 2007. Exploring Flexibility in Stadium Design, Master Thesis, Department of Architecture, The Massachusetts Institute of Technology (MIT), USA, 47 p.
- Kairamo, M. 1999. The renovation of the Olympic Stadium, Helsinki, in: *Monuments and Sites, Finland, The Finish National Committee of ICOMOS*. Mexico, p 192.
- Kiuri, M. 2009. *Estadio olímpico, espacio cultural – un lugar de la memoria*, Ed. UCJC, Madrid. 100p.
- Kiuri, M. 2007. La Memoria Olimpica, "The Olympic Memory", Doctoral Thesis, University CJC, Madrid. 330 p.
- Kiuri, M. 2009. "Juegos Olímpicos y arquitectura" (Olympic Games and architecture) and "Juegos Olímpicos, arquitectura y medio ambiente" (Olympic Games, architecture and environment), In: *Olimpismo y Deporte (Olympism and Sport)*, UCJC (edt). Vol. 25 & 26, Madrid. 395 p.
- Kiuri, M, Teller, J., 2012(a). Olympic stadiums in their urban environment: A question of design and cultural significance. *Journal of Cultural Heritage Management and Sustainable Development*, 2(2), 115-129.
- Kiuri, M, Teller, J. 2012(b). The Stadium of Olympia from the perspective of dialogical architecture. *Proceedings of International Workshop Architecture, Education and Society – UPC*.
- Kupfer J., 1990. From edifice to device: Architecture of disengagement. *Technology in Society* 12 (3): 319-332.
- Lazzari M., Majowiecki M., Vitaliani R.V., Saetta A.V., 2009. Nonlinear F.E. analysis of Montreal Olympic Stadium roof under natural loading conditions. *Engineering Structures* 31 : 16-31.
- Liao H. & Pitts A., 2006. A Brief Historical Review of Olympic Urbanisation, *The International Journal of the History of Sport*, 23. pp. 1233–1255.
- Liu X., 2005. Introduction of structures of some stadiums and gymnasiums for Beijing 2008 Olympic games. *Avances in Steel Structures* 1: 361-365.
- Marshall, T., 2000. Urban Planning and Governance: Is there a Barcelona Model? *International Planning Studies* 5(3), 299–319.
- Martinson, R.J., 2009. A real Options Analysis of Olympic Village Development: How Design Flexibility Adds Value, Master of Science in Real Estate Development. The Massachusetts Institute of Technology, 79 p.
- Myer A., Chaffee C., 1997. Life-cycle analysis for design of the Sydney Olympic Stadium. *Renewable Energy* 10 (2-3): 169-172.
- Nixdorf, S., 2008. *Stadium Atlas*, Ernst & Sohn Verlag für Architektur und technische Wissenschaften GmbH & Co. KG, Berlin, 368 p.
- Official Website of the Beijing 2008 Olympic Games. <http://en.beijing2008.cn/>, accessed in October 2012.
- Official Website of the London 2012 Olympic Games. <http://www.london2012.com/>, accessed in October 2012.

- OCOG (Organizing Committee for the Olympic Games) 1963. The Games of the XVII Olympiad. Rome 1960. The Official Report of the Organizing Committee. V.2. Colombo Publisher, 1072 p.
- OCOG (Organizing Committee for the Olympic Games) 1964. The Games of the XVIII Olympiad. Tokyo 1964. The Official Report of the Organizing Committee. v1., 664 p.
- OCOG (Organizing Committee for the Olympic Games) 1969. Games of the XIX Olympiad, Mexico'68. The Official Report of the Organizing Committee of the XIX Olympiad. Part II. Plans and Preparations. 163 p.
- OCOG (Organizing Committee for the Olympic Games) 1972. The official report of the Organizing Committee for the Games of the XXth Olympiad Munich 1972. V. 2 The Constructions. Sport München. 98 p.
- OCOG (Organizing Committee for the Olympic Games) 1978. Montreal 1976. Games of the XXI Olympiad. Official Report. VII. Facilities. COJO 76. Ottawa. 239 p.
- OCOG (Organizing Committee for the Olympic Games) 1981. Official report: Games of the XXII Olympiad. Moscow 1980. V 2. Organization. Moscow, Fizcultura i Sport. 306 p.
- OCOG (Organizing Committee for the Olympic Games) 1985. Official Report of the Games of the XXIII rd Olympiad Los Angeles, 1984. V.1.Organization and Planning. 302 p.
- OCOG (Organizing Committee for the Olympic Games) 1988. Official Report. Organization and Planning Volume 1. Games of the XXIVth Olympiad. Seoul.
- OCOG (Organizing Committee for the Olympic Games) 1992. Official Report of the Games of the XXV Olympiad Barcelona 1992. V. The means Objectives, resources and venues. II. Published by COOB'92, 431 p.
- OCOG (Organizing Committee for the Olympic Games) 1997. The Official Report of the Centennial Olympic Games. V I. Planning and Organizing. Peachtree Publishers. Atlanta. 584 p.
- OCOG (Organizing Committee for the Olympic Games) 2001. Official Report of the XXVII Olympiad Volume One: Preparing for the Games. 420 p.
- OCOG (Organizing Committee for the Olympic Games) 2005. *Official Report of the XXVIII Olympiad*. Homecoming of the Games - Organisation and Operations 1. Athens. 544 p.
- OCOG (Organizing Committee for the Olympic Games) 2011. *Official Report of the Beijing 2008 Olympic Games*. Volume II. Ceremonies and Competitions: Celebration of the Games.« 运会2008»;“图书馆 CIP (2010) 160049”, digital version: LA84 Foundation.
- Owen, C. (2008). Architecture between the culture-nature dualism: a case study of Geoffrey Bawa's Kandalama hotel. *International Journal of Architectural Research*, Vol.2 (1) pp.40 - 56.
- Sheard, R. 2001. Sports architecture. Spon Press, London-New York, 227 p.
- Shen Z.I., Chen Y. I., Liu Q., Zhao X., Yao N., Lin Y., 1996. Experimental study on the spatial roof structure of 80,000 - seat stadium in Shanghai. *Advances in Steel Structures* 1: 601-606.
- Sklair, L. 2006. Iconic Architecture and capitalist globalization, *City*, 10(1), pp. 21-47.
- Schmidt, T. 2002. Olympic Stadiums of the modern age – construction trends of the 20th century, in: Sport Sites Culture ICOMOS *Journal of the German National Committee XXXVIII*. ICOMOS, Nationalkomitee der Bundesrepublik Deutschland, 96 p.
- Tyrrell, T and Johnston, R., 2001. A framework for assessing direct economic impacts of tourist events: Distinguishing origins, destinations and causes of expenditures. *Journal of Travel Research* 40(1), 94–100.
- IUA (International Union of Architects) 2012. Report of the International Union of Architects (IUA), Sport & Leisure Working Group of 4th May 2012. RIBA Seminar London. <http://www.uia-sport.com/> accessed in November 2012.
- UNAM 2005. Technical file for the nomination of Campus central of the UNAM for the inscription in the UNESCO World Heritage. UNAM, Conaculta, INAH, Mexico, pp. 257. p. 26.

- Unesco 1972. Convention Concerning the Protection of the World Cultural and Natural Heritage, adopted by the General Conference of the United Nations Educational, Scientific and Cultural Organization (UNESCO), available at <http://whc.unesco.org/en/conventiontext/>. Accessed in November 2012.
- Unesco 1989. Decision – 13 COM XV.A – The World Heritage Committee, Internal report, available at <http://whc.unesco.org/en/decisions/3634>. Accessed in November 2012.
- Unesco 2005. The criteria for selection. <http://whc.unesco.org/en/criteria>, accessed in November 2012.
- van Winkel, C. 2000. Dance, discipline, density and death: the crowd in the stadium. In: *The Stadium: The Architecture of Mass Sport*, Ed. Michelle Provoost, NAI Publishers, Rotterdam, p. 183.
- Vegara, A. 2005. Strategic plans for cities. In: *New Trends in Management of Major Sport Events for Development of Cities: Selected Readings*, I Urdangarin and D Torres (eds.). PricewaterhouseCoopers, Valencia.
- Velluet, P. 2012. Wembley Stadium – the loss of the much-valued twin-towers. Sustaining Memory, in: Sporting Heritage- Sustaining memory. *Conservation bulletin* 68: 23.
- Yuen B., 2008. Sport and urban development in Singapore. *Cities* 25: 29–36.
- Zhang Q., Liu M., Wu C., Zhao G., 2007. A stranded-crowd model (SCM) for performance-based design of stadium egress. *Building and Environment* 42: 2630–2636.

Miranda Kiuri

Scientific staff, Dr. Arch.

University of Liege, Faculty of Applied Sciences, Department ArGEnCo, Lab. LEMA

miranda.kiuri@ulg.ac.be

Sigrid Reiter

Professor, Dr. Ing. Arch.

University of Liege, Faculty of Applied Sciences, Department ArGEnCo, Lab. LEMA

Sigrid.reiter@ulg.ac.be