SUSTAINABILITY IN ACOUSTICS: LONDON 2012

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1 INTRODUCTION

The Olympic Games have inspired humanity for over a century. It could be considered as the most popular and most significant recurrent hallmark event in the world. Hallmark events do not only seek to present an opportunity of high prominence in the tourism market place (Hall, 2004), but also seek to introduce lasting legacies which can be emulated (Levett, 2005). Since the "greening" of the Olympics Committee's objectives for organising Olympic Games, there has been a dramatic increase in various Olympic bids incorporating the concept of sustainability (Lenskyi, 2002). The focus of rival bids has been to compete in concepts which have lasting legacies not only to the natural environment, but also present schemes, beneficial to the community. This is in compliance with one of the Olympic Committee's main objective of organising Olympic Games, which is to have no negative net impact on the environment (3NEI), leaving behind a positive green legacy.

The concept of Sustainability in acoustics within the context of the London 2012 Games could be considered to entail organising an Olympic Event that lays equal weight on the ambient noise environment climate, and noise sensitive receptors like any other major development. This includes the effects of long periods of construction noise and vibration (2007 – 2011), the noise generated by facilities during the duration of the ceremony and the associated transportation, and finally the long term legacy of the residual impact on human health and happiness created by the changes in the built environment and the corresponding change in ambient noise climate. Implementing innovations that integrate the concept of safeguarding and the improving "acoustic comfort" from the design phase onwards within the framework of lasting legacies to humanity should in effect be positive contributions towards the ambient noise environment and sustainability as a whole. A sustainable Olympics with 3NEI will encompass co-operation between a wider spectrum of government bodies, NGOs, the private sector and the local community, thus ensuring that wildlife, plants, water, air, soil and the processes that connect them will be enhanced, or at least be in no worse state than at present. Such collaboration has already been partly reflected in a joint initiative between BioRegional and WWF called "Towards a One Planet Olympics" which was set out as part of the bid for the London 2012 Games. It stated that "improved soundscape" was a goal for the legacy phase of delivering the health and happiness element of a sustainable Olympic Games. It also mentions the need for "Healthy internal environments in homes and other facilities".

Sustainability is a multifaceted entity which can certainly play a major role in ensuring that implementing the games embraces measures that could create synergies in ensuring that the ambient noise environment around the Olympic venues and London is not worst in 2012 and beyond. With the increasing importance and public awareness of the effect of noise and vibration and the resulting impacts on well-being, acoustics is becoming an essential consideration in the delivery of sustainability, primarily through the quality of the ambient noise environments (Kang; et al. 2005). This paper will discuss the role of sustainable acoustics, with emphasis on the collective measures that encompass the concept.

The paper will be in two parts. Firstly, sustainability in relation to multi-complex and mega features of hallmark events with respect to impacts on the ambient noise environment will be explored. Secondly, the role of sustainability within the framework of acoustics for London 2012 will be discussed, coupled with suggestions for an integrated approach towards incorporating sustainability issues through the design, implementation and operational phases with considerations for acoustic comfort of the people taking part, witnessing and living with the legacy of the event. This will discuss sustainable measures that have already been proposed and put forward further ways through which the sustainability principle can benefit from acoustic design. An integration of all such measures

within the wider context of creating sustainable solutions may generate innovative synergies which could in effect strengthen and promote the delivery of sustainability through good acoustic design as a crucial part of the whole sustainable solution.

2 OUR NOISE ENVIRONMENT AND HALLMARK EVENTS

2.1 Impact on the acoustic environment:

Recent studies including the UK National Noise Incidence Study 2000 have highlighted the fact that our acoustic environment in the UK is potentially unsustainable with levels against the ideal benchmarks set by the World Health Organisation in their Guidelines for Community Noise 2000. Also, Defra's review of noise and Health Effects in 1998 concluded that identifying health effects that result in a case by case basis is fraught with difficulty, and that it remains a public perception, but relevant to the issue of peoples quality of life. However the case for noise affecting health of the population and the cognitive function of school children has become strong (RNID 2006). The effects of noise emissions continue to pose a major problem to our quality of life and therefore by definition our health. Noise is a result of our daily activities, and the modern human society entirely depends on different machines and tools which are often noisy. The global family also relies on mega events and festivals, which are organized to serve as a symbol of global peace and unity, and promote global intercultural relations. Potential hosts cities realise an opportunity to fast track urban regeneration, in effect, a stimulus to economic growth, improved transport and cultural facilities (Chalkey & Essex, 1999). Above all, an enhanced global recognition and prestige is sought. The resulting economic and community benefits which serves amongst others as the main rationale behind hallmark events are widely considered as trade-offs to the resulting environmental impacts. However, the sum of all the innovations of hallmark events, ranging from changes in urban landscape to the actual events, indirectly results in changes on the ambient noise environment. Hallmark events as a result, do generally result in a culmination of activities which may be unsustainable as a result of noise on people's health and wellbeing. This includes for example, the ability to tolerate 4 years of construction noise prior to the event, which could result in levels of 70dB(A) outside the existing communities homes. There is a real danger of causing nuisance, which over 4 years could not be considered temporary. This could lead to sensitivity of the community prior to the short lifespan of the event. Once the immediate impact of the event has subsided then a legacy that might include an altered ambient noise climate is not necessarily going to lead to an outcome that could be considered as sustainable. Many of these activities may result in impacts that will require acoustic interventions and design solutions to ensure the outcome is a positive one, rather than simply neutral.

2.2 Hallmark events and deregulation of noise provisions:

Despite the many benefits of hallmark events, they at times endanger laws incorporating participatory procedures and environmental safeguards. This may consequently trigger trends which may be considered unsustainable as a result of the negative impact on well-being. Laws preventing noise pollution are at times most vulnerable during hallmark events as a result of the generally noisy atmosphere associated with the events and the relative short term duration. For example, in the recent FIFA World Cup 2006 in Germany, the "Bundestag" passed a law exempting all World Cup matches from the noise protection provision under the pretext of ensuring that Germany was a welcoming host of the World Cup. This in effect portrays the little importance attributed to the impact of noise to the quality of life of individuals residing within the vicinity of the hallmark event, and also highlights that communities may become initially oblivious to new noise sources during hallmark events as a result of noise masking from activity sources, or the "feel-good" effect attributed to the social benefits and a boost in civic pride associated with hallmark events, which becomes more obvious and invasive after the event has ended. The long term impact needs to be carefully considered to claim a sustainable approach has been taken, with regards to acoustics.

2.3 Cumulative noise effect of hallmark events and trade-offs:

Noise from hallmark events especially at night time could have a short term unsustainable impact i.e. may create annoyance which can indirectly have an adverse impact on human well-being. Also, mental activities involving high load in working memory, such as sustained attention to multiple cues or complex analysis, are all directly sensitive to noise and performance suffers as a result (Cole; et al. 2005). Associated activities including increase in traffic congestion, air flights and train time frequency as a result of increased mobility of visitors associated with hallmark events are the main causes of spatial increases in noise levels. These increases in noise levels may be considered unsustainable when compared with the desirable absolute levels set by the WHO. It could be argued that the noise impact of hallmark events is temporary and the economic benefits resulting from the hosting of such events off sets the impacts, often superseding the annoyance and health impacts at any given time. The social benefits from hallmark events are thus considered as trade-offs to the temporary or at times permanent impacts of the event. However these trade-offs with social benefits might only be beneficial if directly balanced with the protection or enhancement of acoustic standards for the affected community, such as less traffic noise affecting amenity areas e.g. gardens and internal spaces. Nevertheless, research has shown that residents and businesses have been found to trade negative factors such as noise, litter and parking problems against positive factors such as good transport connections (VivaCity2020, 2006).

Acoustic engineering applies principles such as layout design, use of noise control at source or through screening as measures within the framework of sustainable design which could minimise resulting noise impacts. The remote location of some hallmark events away from main residential areas or city centres is a good measure to limit the impacts of the resulting noise. However, the opening up of areas previously inaccessible to development and indirect events could be considered as new sources of noise. Most hallmark events fall short of extending their impact assessment scenarios to include the effects resulting from activities indirectly resulting from their event, although copy-right infringements regulating activities that are organised in the name of the Olympic Games are strictly monitored. This in effect results in increments in noise level although not significant enough to warrant mitigation at times since the increase in noise levels are considered insignificant as per legislative standards (<3dBA). However, noise changes up to 3dB(A) could be compared to a doubling of road traffic and is perceivable by humans as a change to the existing noise level. This can lead to an upwardly “creeping” background.

2.4 The Olympic Legacy and Acoustics:

Olympic Games nowadays are always accompanied by mega structures boasting innovative technologies to raise the standard of the Games above that of previous events. Within the context of sustainability, events like the Olympic Games now seek to ensure that newly constructed facilities are transformed into other uses after the Olympic Games. These transformations may fail at times, in that the post-Olympic use of the facilities proposed in the Legacy Phase may result in a form of use that could potentially result in a noise level that cannot be usefully controlled by pre-Olympic noise control measures. It can be assumed that existing legislative guidelines will regulate the use of these facilities and ensure that noise emissions meet stipulated thresholds. However, meeting stipulated thresholds do not necessarily mean that a positive effect to the “soundscape” will be achieved to implement the aims of the legacy phase. Annoyance or degradation of the noise climate may still be caused to the community within the immediate vicinity of the converted facility. This could be detrimental to the quality of life of the occupants, hence unsustainable since the well-being of the immediate community would be under threat of deterioration.

A summary of temporary and residual noise impacts of mega hallmark events have been presented. It indicates that the concept of the Olympic Games generates processes and activities that directly or indirectly lead to either positive or adverse effects on the existing ambient noise environment (or soundscape). Some indirect impacts which arise from the wider context of these events may sometimes be permanent, i.e. residual. The Noise Assessment of the London 2012 Olympic Games assessed the significance of the effect of construction noise as “marginal to minor” with a residual impact of the noise from the event as “minor to neutral”. The residual impact is rated as “neutral”.

An impact of marginal to minor during construction refers to consistent noise levels that will achieve up to 70dB(A), which over 4 years may not be such an innoxious impact as suggested. “neutral” significance does not mean that there are no residual noise impacts, or an improvement in the existing noise climate resulting from the organisation of the games, after the use of best available technology. To achieve the aims of 3NEI it is considered that the ambient noise environment should achieve at worst no residual noise impact, and also, that the principle of sustainability should be applied by attempting to improve the noise environment as far as practicable as possible. The preparation and the organisation of the games does not appear to go to these lengths presently to provide reassurance that the impact of the noise produced by the project would be insignificant, or that there would be improvements to the future noise climate. For an event on the scale of the Olympics such measures should aim not only to minimise the effects of noise, but also ensure that the legacy should not affect humanity, or wildlife on a greater scale. Within the framework of sustainability in acoustics there should be an engendered approach towards implementing a lasting sustainable legacy, as aspired to by the Olympic Delivery Authority (ODA).

3 AN INTEGRATED APPROACH TOWARDS SUSTAINABLE SOLUTIONS FOR ACOUSTICS IN THE LONDON 2012 GAMES

Mega hallmark events on the scale of the Olympic Games have a wide range of impacts on the environment. Noise is one of these impacts. The Olympic Games consists of multipurpose constructions, urban design and events which may adversely affect the biosphere in one way or another. In the light of organising a sustainable event, other environmental impacts may arise, including noise, from those sustainable solutions (Kang; et al. 2005). For example, the proposed wind turbine and CCHP for the Olympic Village may result in low frequency noise, and the CCHP may also contribute towards air and noise pollution. A culmination of all these effects may result in an adverse impact on the existing ambient noise environment.

In the words of Lord Coe, the ODA seeks to "*set new standards for the sustainable design and construction of major sports venues and infrastructure used for the games*", and also …"*We intend to set the very highest standards in sustainability and legacy for other games to follow*." The highest standard of sustainability should not be limited to popular sustainable attributes e.g. water, air and energy, waste and recycling. Within the context of sustainable development, the highest standard of sustainability should encompass a combination of several if not all receptors which should include noise effects. Although this is hard to achieve, efforts should be made to incorporate quality of life issues within the wider context of sustainability. Quality of life aspects of the Olympics should not be limited to recreation and transport facilities, but could go a step further to raise the standard in dealing with the impacts of hallmark events with respect to the impact of noise generated by these facilities and the soundscapes that are left for others to live with.

Sustainability is a multifaceted concept which could be applied in different contexts. Within the context of London 2012 it is understood to consist of minimising the environmental impacts of the pre- and post-phases of the games. Developing sustainability within the context of noise refers to the effect on well-being including tackling:

- Noise which gives rise to noise-induced hearing impairment;
- Noise ingress into buildings, which deteriorates the quality of life by causing sleep disturbance, speech interference and/or severe annoyance;
- Noise which interferes with speech communication, learning and teaching in a society built on knowledge.
- Noise affecting amenity areas such as gardens, parks, reserves that give rise to levels considered likely to cause annoyance or an adverse effect on health and the ability to relax reasonably.
- existing areas of “tranquillity” (areas absent of man-made noise), or where noisy amenity areas could be made such they become areas of “tranquillity” which can be enjoyed as “soundscapes”.

These are all situations where noise will affect the well-being of communities and may therefore put any development at risk of being unsustainable acoustically. The approach for sustainable acoustics is to neutralise an existing impact and attempt to turn it into an improvement for each of the categories listed. The focus of sustainability within the context of acoustics should therefore encompass collective interventions across several disciplines, which will culminate in protecting the ambient noise environment from further increases in noise levels, and by implication secure the well-being of human beings inside and outside of the built environment.

Sustainable acoustic measures could be stand-alone measures or a combination of processes which could in turn lead to the protection and improvement of the environment. This will require a combination of regulatory bodies and institutions, combining policy, technological and participatory tools. All measures implemented to minimise the impact on, or enhance the acoustic comfort of the community within the vicinity of the Olympic Village today and in the future will constitute an application of the concept of sustainability in several forms. Such interventions should constitute measures that incorporate the concept into the design process from the conception to implementation and subsequently operation.

3.1 Sustainable Design and Procurement

Sustainable Building and the use of the sustainable building code are new measures aimed at improving the comfort of homes and minimising resource use. The New Code of Sustainable Homes for example, could be pro-actively used in the construction process of the Olympics to ensure that an enhanced acoustic comfort level, above the minimum sustainable building design specification is achieved. This will provide a benchmark that the UK Government will require similar schemes to comply with. It will be a chance to gain credits for enhanced sound insulation between habitable areas. Although the design code does not include any requirements for guiding design of the external noise environment presently, an innovative event such as the Olympic Games could set parameters that could trigger standards for the design of the external noise environment. This will ensure that acoustical design prevent excessive internal noise transfer and minimise the ingress of external ambient noise to within WHO targets.

During the design phase of the Olympic Games, the envisaged sustainable procurement could acquire material and techniques that would effectively reduce noise levels whilst encouraging the requirements for use of low embodied energy materials. Sustainable procurement will ensure that material acquired for acoustic implementations have proven environmental product stewardship. The use of acoustic material e.g. glass fibres, which may have health implications to room occupants should be avoided. The concept of Indoor Environment Quality (IEQ) could be considered throughout the Olympic Games, from design to construction, and especially during the Olympic Legacy Phase. This may optimise the IEQ to ensure a sustainable wellbeing to the future occupants and also ensure a sustainable environmental performance of the Olympic Village and other facilities.

3.2 Acoustic Interventions

Sustainable design and building may at times not naturally ensure an enhanced level of acoustic comfort to the occupants of buildings and facilities, and often encourages the use of natural ventilation in areas where noise ingress can become problematic. The protection of the indoor acoustic environment is currently recognised as very important to allow school children for example and occupants of other sensitive premises like hospitals to be able to learn and function effectively. Enhancement of the acoustic protection for important residential spaces such as bedrooms is also a driving consideration if noise ingress from the external ambient noise environment is not tackled. A strategic approach to delivering sustainable acoustics as part of the Olympic Legacy could identify and propose specific measures to protect the well-being of athletes, residents and future users. An Olympic Noise Strategy is needed for example, that would identify where noise environments can be improved. Such measures could include replacing noisy transportation routes with much quieter

alternatives. It could focus on potential noise hotspots and propose appropriate mitigation interventions. This could particularly focus on the facilities that are planned to be permanent, for example the proposed CCHP and wind turbine for the Olympic Village. For venues identified as sensitive to high noise levels during the Olympic Games a more proactive approach to noise control, which could include active noise management of the event could be utilised.

3.3 Integrated Urban Design

The urban nature of the proposed site in east London brings about further need to achieve acoustic sustainability as rapid development areas are especially vulnerable to increases in road traffic noise, which is perhaps the most widely affecting source of noise in society today. The Olympics have been hailed as a key to the economic regeneration within the Lower Lea Valley, an area considered to be in economic decline (ODA, 2006). A balance needs to be found between regeneration at any cost and the well-being of the community within it. Integrated urban design and landscaping may for example use vegetation to improve environmental aesthetics. On its own this will not act as a noise reduction measure, but in combination with acoustic barriers and bunding, landscaping can be an effective noise mitigation measure. Other integrated solutions could be the use of materials for construction. If it is not possible to plan and divert roads away from noise sensitive areas or introduce quieter sources of transport, then the use of low noise emission surface treatments roads would utilise solutions already tried and tested on large sections of the M4 motorway for example. The careful design of the urban transport system could use such approaches to ensure that future inhabitants of the Olympic Village during the legacy phase will be less dependent on cars, but instead, on low noise emitting public transport such as bicycles, monorails or quiet alternatives. Also,“car-free” games could ensure that athletes are encouraged to embrace the concepts of sustainability and demonstrate to the population by example how they could change their lives to help deliver sustainability more widely. This would build on the approaches used in Sydney 2000, where bicycles were offered for mobility between the Olympic Village and the venues.

The use of computer modelling has produced road and rail noise maps, aimed at identifying key areas that would be affected by any noise that would be produced during the lifecycle of the Olympic Games, and the subsequent redevelopment of the area. To achieve optimal integrated urban design, measures should ideally be undertaken to strengthen the acoustic protection of noise sensitive developments during the Olympic legacy and to provide, preserve or enhance areas where tranquillity can be provided as part of their soundscapes. This can be done my means of using noise mapping to help inform design choices, and a noise action plan.

3.4 Noise Regulations

The use of noise mapping to inform noise strategies has recently been prescribed by the EU Noise Directive (ENDS) This has resulted in the Environmental Noise (England) Regulations 2006, which came into force 1st October 2006 and is currently in the first phase of implementation across the UK, The deadline for councils to submit the first noise maps and action plans for agglomerations is 30 June 2007. The delivery of the Olympics provides an opportunity to make use of this approach, to again illustrate how noise action plans will help to inform planning decisions in the future. There is a requirement to identify and consider how to protect quiet areas. Defra commissioned TRL to review how to identify quiet areas and how to define a definition to identify them. They identified that in urban areas “good urban outdoor soundscape should; (a) be dominated by positive sounds from nature, and (b) have an overall equivalent sound level below 50 dB(A) during the daytime” (TRL 2006). It is recommended in that report that an upper limit of 50dB L_{den} should be used, with a “gold standard” of 40dB L_{den} be strived for. Here is a tangible challenge for the Olympics to achieve in their legacy.

The developers of the London Olympic Games have been influenced heavily by the need to create an event that will have a reduced impact, incorporating as many possible measures to reduce the adverse impacts, for all aspects, not simply noise effects. By building upon the experiences of

previous host cities, contrasting sporting events and environmental experience, the 2012 Olympics have also laid emphasis on acoustic sustainability. This has been proven in the consideration of international and national noise regulations and best practice. By addressing these regulations the Olympics 2012 came into line with the requirements underlined for the October 2004 Planning Permissions and Section 106 Agreements – Lower Lea Valley Olympic & Legacy Planning Permissions.

Baseline noise surveys were conducted at a number of locations during 2003; these were then repeated at the same locations in July 2006. However, as discussed within the complete Environmental Statement for the site, "noise surveys are only 'snapshots' of the noise environment in an area so do not generally represent a reliable base against which to assess the predicted noise levels associated with future developments". Further monitoring may thus be required and noise maps and action plans considered to demonstrate a strategy that would deliver protection of existing "quiet areas" as defined by the first round of noise maps, and to further provide a sustainable acoustic environment for the legacy phase against established targets. This could include attempts to use changes in the transport system to create new "quiet areas" that can enhance the communities' quality of life.

3.5 The Olympic Sustainable Legacy and Noise Control

The design of the Olympic Park, has concentrated on creating a reduced impact from the Olympic lifespan, rather than providing protection or enhancements to the soundscape of the surrounding area. Modern stadia will have incorporated design requirement to contain noise, and expel as little as possible to the surrounding environment. Construction methods are generally noisy, and use of best practicable means to reduce noise, should be part of any agreed "prior consent" with the authorities. However the impact of 4 years of construction can be expected to be significant, albeit minimised as far as possible. So far the operational phase of the Olympic Games has been merely estimated and spectator noise in the surrounding streets prior to or after an event is not within the reasonable control of the organisers. However, the organisers can control such a situation to a certain level, and typically through multi-lateral collaboration between the local authority, law enforcement and promoters of the Olympic Games. This will ensure that the communities affected are identified and measures undertaken to ensure that the reduction in their quality of life and well-being is not felt. However, controls should be implemented to minimise the impact on sensitive receptors such as residential, schools, hospitals, learning and religious centres. It thus remains the legacy phase that holds the key to the Olympics delivering a sustainable acoustic approach.

As a global event that seeks to promote innovative concepts in sustainable development, it could be expected that the sustainable legacy of the games does not only bolster the image of UK, but should be expected to affect the lives of participants, spectators and finally communities positively. Initiating such synergies will contribute to the dissemination of sustainability through acoustics and consequently through the Olympic network. This could achieve an approach that sets the standards for developed and developing countries alike, who are still coming to grips with environmental management concepts.

4 CONCLUSION

Sustainable development in the context of acoustics engenders the need to consider how to apply the principles of sustainability to the external and internal noise environments experienced by communities. Sustainable acoustics encompasses measures that preserve and enhance the quality of life and well-being of human beings. An event on the scale of the Olympic Games provides a global opportunity to set new benchmarks in the delivery of sustainability in practice. Regard for acoustics through improved "soundscapes" is an opportunity that the Olympic Games should deliver as part of the legacy phase. The Olympic development involves major construction over a 4 year

period and with thousands of people converging in one place over the operational phase is likely to have a balance of adverse as well as positive impacts. The benefits of the noise produced in these phases are unlikely to be completely mitigated, but their effects will be relatively temporary. The most important phase that requires a detailed noise strategy is possibly the legacy phase. The challenge of achieving a sustainable event and deliver the promise made by the ODA in 3NEI should aim to preserve the existing noise climate, but enhance the soundscapes. Where possible this could be achieved by altering the transportation and associated event infrastructure through the use of established and innovative noise control techniques to minimise the ingress of road traffic noise, wind turbine and all other sources of man-made noise into the amenity areas and homes of the communities that will remain. Although the statutory noise levels may be met the challenge is to work with the emerging noise action plans to leave an environment that will provide a good quality of life and well-being for the communities.

A pro-active consideration which exceeds minimum legislative standards for the acoustic comfort of participants, spectators and future users of the Olympic facilities post-London 2012 Games will set standards for future games worthy of emulation globally. This will not only consolidate British dominance in the creative industrial sector, but will create global awareness of how to deliver sustainability in practise in the light of the spirit interculturalism of the Olympic Games. It will promote sustainability globally. This paper has demonstrated how applying the principle of sustainable acoustics is an important part of delivering sustainability as an integrated part of the master planning for hallmark events of the scale of the London 2012 Games. Sustainability in acoustics involves a collective effort between multi-disciplinary sectors of the Olympic Games and could only succeed if considered at the onset of the design to make sure the legacy remains true to the promise.

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