What is the future of stadium design?

Garth Rowland

Aurecon Design Academy Research-Based Innovation

A major component of the Aurecon Design Academy is the individual project-based research paper. The research involved developing technical innovation and application methods for an actual project through experimentation, prototyping and human-centred design. This research paper is the result of such a project and authored by an Aurecon Design Academy graduate.

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Aurecon Design Academy is Aurecon's flagship learning program for technical mastery.

Formalised by RMIT University into a Graduate Certificate in Design Management, Aurecon Design Academy aims to foster eminence and a human-centred, transdisciplinary approach to design problems, enabling us to serve clients through design excellence and innovation.

It is a three-year program delivered via a mix of face-to-face, virtual and remote learning and includes both team and individual assignments and assessments. For those who successfully complete all course requirements, the program culminates in a graduation ceremony held in recognition of their achievements. Entry to the Design Academy is by a competitive application process and takes place annually and those that are accepted to the program are known as Design Scholars.

Following a blended approach with sessions delivered by a combination of Aurecon leaders, renowned academics, and external facilitators, combined with application activities deployed on projects, it aims to develop mastery amongst senior design and advisory practitioners.

Its purpose is to elevate technical mastery at Aurecon to the highest level enabling us to better serve our clients, through design excellence and innovation. Technical mastery is a key principle and core value creator at Aurecon and as such, the Design Academy sets out to help learners develop skills to elevate the value they can offer our clients.
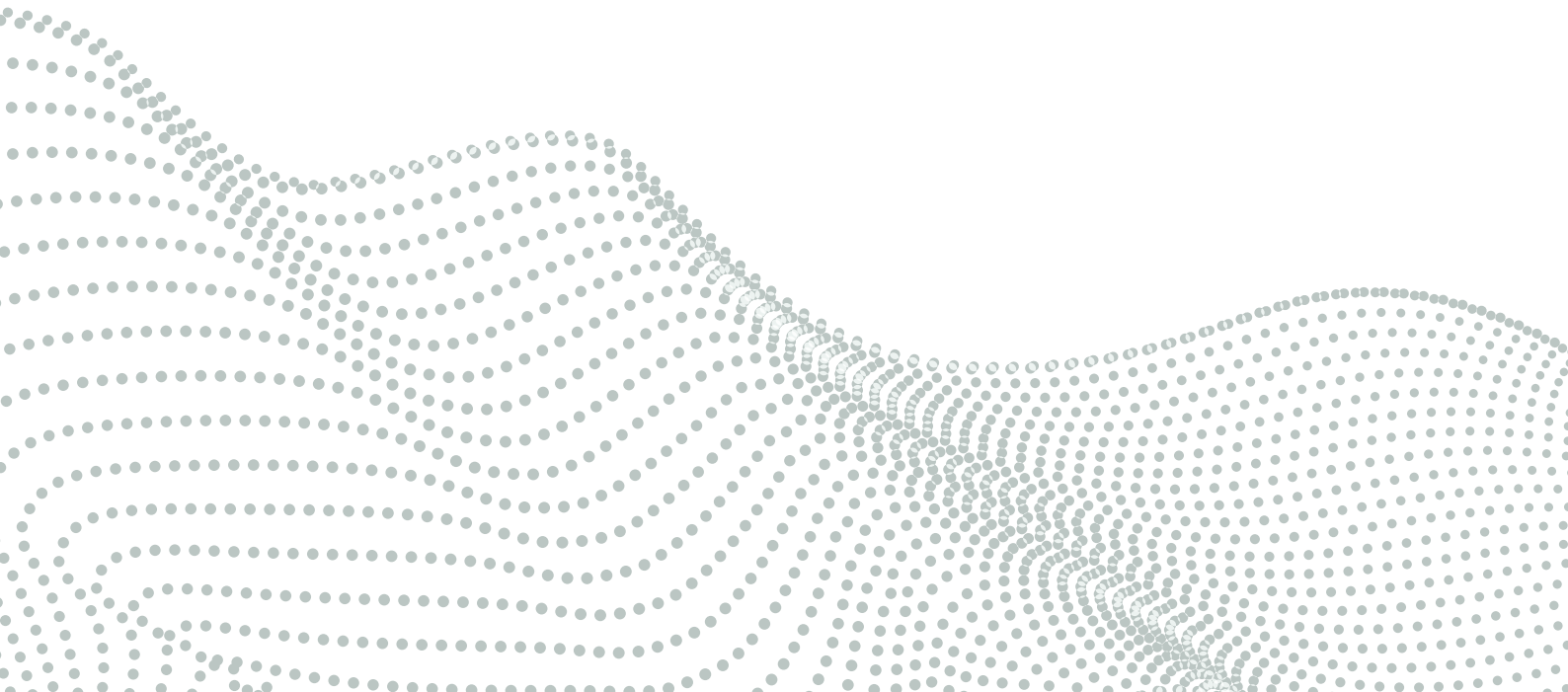
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Executive Summary

1 Executive Summary

The stadium is a highly complex building typology. What defines success in stadia design and operation is difficult to quantify, and indeed varies between different stadia based on many factors including who is making the assessment.

This research paper starts by defining the general design influences of modern stadia and the challenges presented to the stadia designer and the stadia operator. The role of the stadium in the precinct, transport options, design merit, sustainability, commercial viability, and flexibility of operation are critically assessed through the stakeholder experience at the stadium that underpins it all.
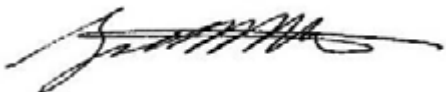
Throughout the paper the research methodology is initially defined, outlining the general principles of stadium design and operation:

- Discussion on the importance of the stadium location and atmosphere

- The commercial viability and flexibility demanded of modern stadia

- The requirement for a human-centred experience based design approach

- Design merit and iconic form

- Safety and security

- Environmental sustainability

Given the breadth of these design challenges, the paper then delves deeper into two key stadia design parameters that are amongst the most dynamic: the response to the COVID-19 pandemic and the ever present security threat among stadia, and examines design solutions to address each and how they interface with the stadium experience.

This research paper consolidates the author's work undertaken as part of the final year of his Aurecon Design Academy journey in his area of passion for the field of stadium design.

He hopes readers enjoy it and thanks the various people who have helped research and write it.

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Figure 1 – Adelaide Oval western grandstand

Introduction

2 Introduction

2.1 Purpose of this Paper

The design of stadia is an inherently complex yet fascinating building typology. A successful stadium design in one location, in one city does by no means equates to a successful stadium in a different location. The originally successful stadium may not even be viewed as successful throughout its operational life, such are the changing demands that it must accommodate. Stadia, perhaps more than any other piece of public infrastructure, attract the public scrutiny and with that comes the adoration or loathing of the public, often at the same time through the community. Stadia designs are often polarising, attracting hundreds of millions of dollars of public monies, occupying premium locations in a city yet sometimes perceived as being used infrequently and perhaps diverting funds from more socially popular endeavours such as health, education and transport. Coupled with the advancement of home entertainment with the latest digital technologies present in the comfort of one's own home, it's at times a seemingly impossible design brief. Yet stadia continue to attract investment, to be constructed and reconstructed, as the experience of live sport and entertainment with your peers can be hard to match. From the Colosseum in ancient Rome to a myriad of modern stadia today, the typology remains popular, and a personal passion of the author's as well.

Figure 2 – The Colosseum, Rome – an ancient stadium

Figure 3 – Wembley Stadium, United Kingdom – a modern stadium marvel

The purpose of this paper is to ascertain the key design parameters in stadia design and operation, identify the primary trends foreseen and to focus on the design and operation for particular challenges in stadia security and health in these days of ever-increasing security threat, as well as the response to the COVID-19 pandemic.

The paper aims to generate discussion with the author's peers and the industry more broadly, and indeed the development of this paper has enabled discussion on stadia design principles with a wide and esteemed global audience. The author aims to illuminate some of the complexities of this building type and to identify ways the design can better serve the stadia operators, the clubs, sporting associations and artists that use them, the broadcasters and principally the fans – the public that access them for the ultimate experience. With the COVID-19 pandemic physically separating communities, friends and families globally, perhaps now more than ever, the thrill of seeing live entertainment in a crowd is yearned for; after all you often don't miss something until it's gone.

This paper forms part of the author's participation in the Aurecon Design Academy, an internal training programme within Aurecon to coach our most eminent designers to think differently, communicate better, collaborate more thoroughly and ultimately become better designers for our clients.

The author hopes readers enjoy it and welcomes their feedback and conversation thereafter.

General stadia design principles

3 General stadia design principles

3.1 Introduction and research methodology

Through his 25-year career to date, the author has been fortunate to work on a number of stadia including the Adelaide Oval Eastern Redevelopment, the Adelaide Oval Western Grandstand, AAMI Stadium Masterplan, Adelaide Oval Redevelopment concept design, Bankwest Stadium Parramatta, Lusail Stadium Qatar, Wyndham Stadium Western Melbourne, Riverbank West Arena Adelaide, in addition to smaller roles on Wembley Stadium London and Margaret Court Arena Melbourne. Through these projects the author has learnt much on the design of stadia; however, the complexity of this infrastructure demands greater focus, particularly to achieve the aims he set himself. It is a typology that the author is passionate about both as a designer, a sports and entertainment fan and an avid tourist.

The author's research commenced comparatively unbiased, deliberately trying to research general principles and ask open questions looking to identify stadia design issues and opportunities without influence from his personal experience. The author sought to focus the paper on the issues critical to the industry. The initial process was broad and inviting collecting a wide range of information, views and opinions to then focus his attention on completing the paper.

The approach to assembling his research was threefold and iterative:

- Literature review – using the facilities afforded by the program collaborator in RMIT, the author worked through a large variety of articles published online around the subject to help inform and narrow his focus

- SurveyMonkey – an open survey was undertaken, advertised through various internal and external social media platforms and receiving more than 100 responses to questions aimed at understanding a relatively narrow cross section of public views

- Stakeholder interviews – the author was fortunate to hold targeted interviews with prominent members of the stadia design and operation community globally, which were as informative as it was inspiring. These interviews created much of

the content the author subsequently developed and to that group in particular he owes a debt of thanks.

Having established the research, the author then narrowed his focus to identify an area of engineering design – stadium security and health, to further focus his subsequent attention. The design of stadia is so broad and varied that to cover all aspects would be impossible and indeed would likely evolve during the course of writing. Stadia security resonated with many of the discussions and interviews coupled further by COVID-19 and the implications for health design in a stadia that were added.

3.2 Literature review

The literature review was undertaken throughout the research paper, forming the first and last activities and many in between. The literature research was extensive given the resources afforded to us through RMIT. Key papers and content is referenced within the paper with the bibliography at the rear of the paper identifying the key content reviewed.

3.3 SurveyMonkey survey

The survey aimed to generate as much public opinion as possible on 12 key questions to help narrow the research focus and set the scene. The survey was open for approximately four weeks and publicised internally through email, Microsoft Teams and Yammer and externally through email, Facebook and LinkedIn. In total, 114 responses were received, which was a positive outcome and provided useful insight to help focus the research.

The detailed results of the SurveyMonkey survey have been included in Appendix A. The following were the key themes that arose from the survey feedback that helped inform the interview process and the subsequent generation of this paper.

Stadium Location

The survey results indicated that location was a key indicator of a successful stadium. Proximity to public transport was a key driver with large venues and crowds making private vehicles less attractive. The interface of the stadium with the city was also important with connection to the entertainment precincts, including bars and restaurants well received. The event experience at stadia has evolved into a greater day and night experience, so a connected precinct was significantly endorsed.

Atmosphere

The ability of a stadium to generate an atmosphere beyond that which can be experienced at home is a key driver to stadium success. Stadium size was viewed as less critical provided the critical mass and energy of a capacity crowd can be generated. Coupled with the crowd experience were drivers around the comfort of the patrons including weather protection, comfortable seats, unobstructed close viewing and affordable costs.

Commercials

Funding for stadia is often controversial with large public monies required for the original capital investment. However, the survey results were unequivocal that the stadium needed to be self-sustaining during operation, while still achieving a value for money experience for attendance.

General Considerations

Based on the free text responses, further general themes were identified. The responses were many and varied but fell into a few key categories:

- Technology – digital connectivity, data and statistics, connection with a mobile phone

- Food and beverage options – a desire for improved variety and quality of food, including a push away from fast food to healthier options

- Affordability – the costs of the stadium experience from ticketing to food and beverage and merchandise

- Ease of access – presence for public transport, improved facilities for cyclists, taxi and ride share facilities, autonomous vehicles a future provision envisaged

- Variety of seat offerings – sit/stand seating, different tiers of general admission, members and corporate offerings

- Atmosphere – the importance of an active and vocal crowd to the experience, which has been emphasised this year with sporting events being held without crowds due to COVID-19

- Flexibility and adaptability – the ability of the stadia to operate between events, a more active facility, able to accommodate different events easily

- Safe and secure – to be able to attend in comfort, easy and carefree, enjoyable, safe

- Full experience – from arrival and pre-event to the event itself and then post-event and departure – the desire for the stadia experience to be broader than just the event

- Activated precinct – stadia within a precinct to facilitate activity before and after an event and on non- event days, connected to other activities and experiences

- Sustainable – stadia need to be environmentally responsible, a role model to the community

- Design – iconic and memorable, connected to the city and community, architecturally expressive

The trends identified in the SurveyMonkey made for interesting reading and generally appeared to envelope the author's research. Finding the solution to these challenges remains the key brief.

Refer to Appendix A for detailed SurveyMonkey results and discussion.

3.4 Stakeholder interviews

Introduction

Building on the SurveyMonkey feedback of the 114 respondents, attention was focused on some truly eminent people within the stadia design and operation industry. The willingness of these individuals to generously give their time, and so openly and insightfully share their experience and observations was inspiring, and a definite highlight of the author's entire Aurecon Design Academy experience over the past three years.

Interviews were held over a three week period through March and April 2020. This period will ultimately be memorable for many globally, as it coincided with a general world-wide response to the COVID-19 pandemic with governments progressively banning community gatherings, ultimately leading to the cancellation of all sporting and entertainment events across the globe. With the interviewees almost exclusively working in the business of stadia and event design, operation and planning, it was a stressful time coupled of course with the greater health risks to the broader community. The coronavirus pandemic did give rise to an interesting series of discussions on the future of stadia: when the world eventually recovers from this health and economic crisis, the implications for stadia will be interesting to observe. As with most responses to COVID-19, there is a general requirement to wait and see and stay agile in the response – something stadia design demands anyway; however, not to the scale of disruption that 2020 has yielded.

Interviewees

Eleven eminent people were interviewed across the fields of architecture, stadium operations, sport associations, entertainment, stakeholders and engineering. The interviewees were very generous with their time and very open with their feedback.

The people I was pleased to discuss my research with were:

Architectural

1. J Parrish – Formerly Lobb (Populous), Head of Sport Architecture at AECOM.

2. Chris Paterson – Director, Populous

Stadium Operations

3. Natasha Thiebaut – Bluerock Sports Management

4. Luis Silva – Bluerock Sports Management

5. Peter Wearne – Melbourne Cricket Club, General Manager Facilities

6. John Beattie – President, European Stadium and Safety Management Association

Sports Associations

7. Simon Gorr – Collab Projects (ex AFL)

Entertainment

8. Anthony Kirchner – Chief Executive Officer, Adelaide Venue Management Corporation

Stakeholders

9. Dr Sheila Nguyen – Executive Director, Sports Environment Alliance

Engineering

10. Peter Ayres – Buildings Structures Capability Leader, Aurecon

11. Mark Sheldon – Technical Director, Built Environment, Aurecon

Stakeholder Interview Questions

Five simple open-ended questions were raised with the interviewees designed to prompt their thoughts and let them share their experiences and ideas. The five core questions were:

1. What defines success in a stadium for you?

2. What aspect of stadia design and operation causes you the most issues and keeps you up at night?

3. How could engineering design better support you in stadia design and operation?

4. What do you see as the biggest lost opportunity in stadia design that if unlocked would create the most benefit?

5. What do you see as the future of stadium design and the stadium experience?

The responses were enlightening and varied so, in the following sections, the key themes from the interviewees are captured. In the interest of confidentiality, individual responses aren't identified; however, there was often a strong correlation between individuals indicating a close general alignment.

Question 1. What defines success in a stadium for you?

Defining stadium success among the interview panel generally provided a strong correlation between each individual opinion suggesting that the recipe for success is to some extent defined yet, paradoxically, it does remain somewhat intangible. The obvious responses around commercial viability, flexibility and efficiency resonated through each interview with the emphasis varying between each individual's role. The key commentaries included:

Commercially viable and flexible

It is clear that in the modern world a stadium must have the ability to operate in its own right. As per the SurveyMonkey feedback, while government funding for the large capital investment is generally viewed as reasonable, the cash supplies cannot continue infinitely, so having a venue that can generate its own income is paramount. Conversations focused quickly on design and operating a stadium as a frequently used flexible venue that operates not just for major sporting events each weekend, but day and night, through the week, all seasons and all year round.

Stadia require a robust and well considered business plan that needs to be executed to be successful. The capital investment is large so the returns must be quantifiable and they must be realised.

The flexibility in design morphs into a unique challenge for major venues with seating in excess of say 50 000 often not having the ability to take advantage of this seating capacity outside major events and indeed, many matches attract a less than capacity crowd irrespective. The COVID-19 challenge has also led to operating the venues effectively without any or relatively few spectators, further slashing revenue streams and affecting employment and event offerings.

Figure 4 – Small crowds within large venues are not ideal for commercial viability

Non-event operations frequently feature the hiring out of venues for corporate functions, wedding, parties, and the ever more frequent behind-the-scenes tours, such as sightseeing and roof access walks that are becoming increasingly adopted outside match day to make use of the iconic nature, and often symbolic and scenic venues.

Experience centred

With technology offering patrons and fans high-quality viewing from the comfort of their own home, the focus on attracting patrons to attend the venue is an increasing challenge. The days of being at the game as the only way to view the event and support your team have long been gone, but with the array of technology on offer at home and the increased offerings being provided by the broadcasters, the challenge of attendance is key. While people are social beings and the interactions and atmosphere of the crowd are part of many people's DNA, it is clear that the attraction can wane as evidenced by each sold-out event often ultimately not having a full-capacity attendance. Getting people to buy a ticket and attend are not always complementary and while the ticket revenue is advantageous for the venue, operators and clubs, there is a shortfall in revenue without match day attendance, as well as the loss of atmosphere. With COVID-19 upon us and forced isolation across the majority of the world, it will be interesting to see the recoil for sport attendance and whether fans yearn to gather again en masse and cheer on their teams, to be part of a crowd, and have the stadium experience, or whether the new normal will reinforce stay at home sports viewing with the existing comforts of home coupled with a perceived reduced health risk. This is discussed further in Section 4 of this paper.

A major challenge for stadia designers remains the need to attract fans to the venue or event and ensure the experience offered exceeds that which can be achieved at home. Designing for the experience is becoming a part of a stadia design and a human-centred focus is required to maximise the experience. The expectations of the fans have evolved to include the full experience from when they leave home to when they return, meaning stadia operators are connected to government and other business and services more than ever before. Access to public transport, for example, is a key driver in venue attendance yet clearly is not managed by the stadia operator, so a seamless collaborated experience is needed. If the fan is delayed in transit, feels unsafe or uncomfortable or attracts other negative emotions attendances will fall; hence the focus. These interactions extend to restaurants and bars, retail offerings, car parks and the like on match day, and the commercial and business world during the week.

A recurring key theme in the interviews revolved around the ease of access to the stadium. Fans often arrive late to events and delays for security screening are often poorly received. The future overlay of health screening in the wake of COVID-19 presents a new challenge to operators and venues to add a further screening process, while still maintaining an experience-focused attendance balanced against an increasing security and health threat.
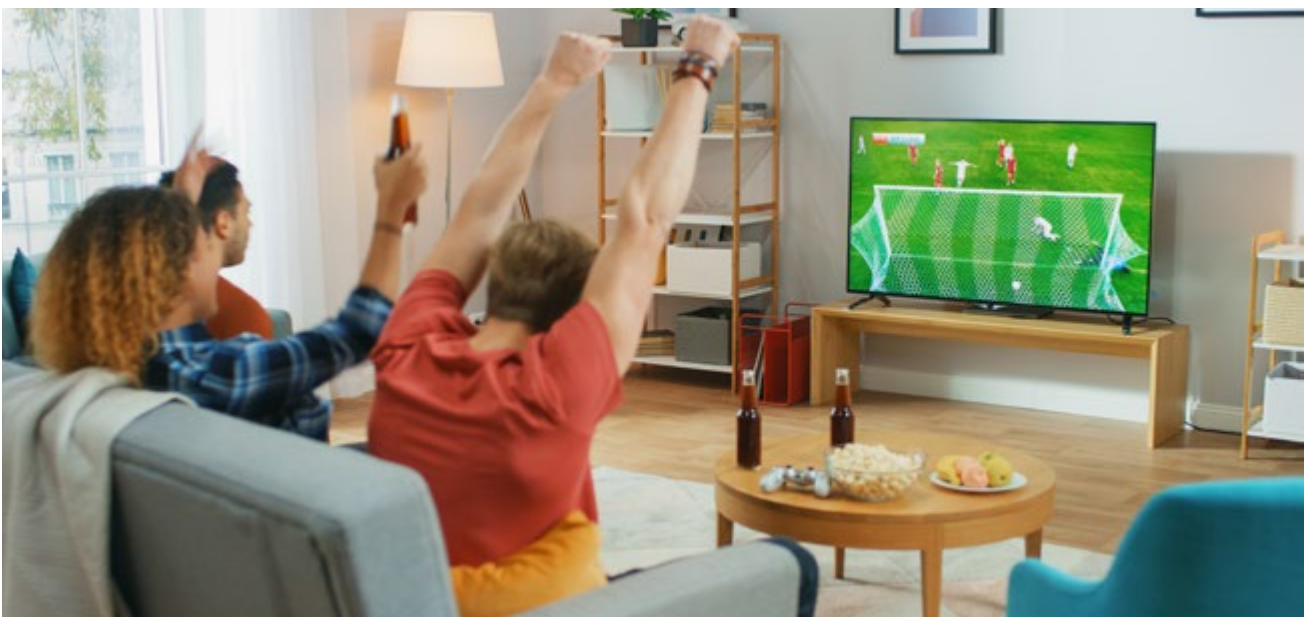

Figure 5 – Household entertainment systems compete with stadia for attendance

Linked to the experience is the ability of a stadium to attract events. While the business plan for most stadia will be linked to a local or national sporting code or team as a series of baseline events, the venue needs to be attractive between them. The entertainment industry for concerts and festivals evolves annually and major artists need surety in the venue to invest their extensive time and resources to attend. The stadia operation needs to be commensurate with these demands to attract the additional events to complement the primary sports. Similarly, smaller venues and function centres need to be flexible, adaptable and be able to be scaled to maximise occupancy between events. A successful stadium needs to be busy.

Operational efficiency

Linked to commercial success is the ability for the venue to operate efficiently, it has to be economical to operate, adaptable to change, environmentally sustainable and do the basics well. The operational design of stadia is relatively well defined through documents such as the Green Guide, and with design briefs such as the FIFA standards for example helping to define the stadia parameters clearly. Despite this, the ever evolving nature of the industry still leads to changes in brief and the requirements, therefore it is imperative to get it right at the outset with the ability to morph as best possible as needs demand.

The operational demands are however complex and varied – administration, broadcasters, sponsors, catering, food and beverage, cleaning, security, operational staff, waiting staff, maintenance staff, ticketing, officials, player facilities, plant and equipment and the like need to be catered for. Stadia sites are often constrained so, while even a large venue has a large footprint, the desire to maximise the areas with a view of field and increasing areas with an external view, mean these back of house areas get squeezed into basements and tucked into seemingly smaller and smaller spaces. Yet, without their consideration, the venue operational cost can skyrocket, threatening the commercial viability and compromising the fundamental spectator experience, further jeopardising success.

Design merit

Stadia, unlike most buildings, can define a city and a community. A successful stadium is one that the fans embrace, the players and clubs talk about fondly, the community respects. A successful stadium is on the postcard and is often one of the symbols of a city, consequently a successful stadium aims to harness these factors balanced against the project capital and operational costs. A well-designed and well-positioned stadium also acts as a catalyst for the precinct and city helping to attract people into the city from locally and abroad and has significant associated engagement for neighbouring facilities. Indeed, the isolated stadium in the outer suburbs of a city surrounded by acres of car parking has gone, replaced with a city-based stadium linked into a bustling precinct that complements adjacent businesses and venues all working together to create the fan experience.

The stadium design now has to look inwards towards the playing surface, but also increasingly be open to the outside to harness the 24-7 experience and flexibility demanded by modern venue operators. Stadia design is heavily specialised and with typically large capital investment can attract designers globally, often more than any other building typology.

A successful stadium design attracts public praise, it attracts patrons to the venue, and it becomes a source of pride to the local community. The converse can also be true.

Question 2. What aspect of stadia design and operation causes you the most issues and keeps you up at night?

The important issues identified during the interview process reflected the key factors for success and the ability to deliver these elements suitably. Commercial viability, flexibility, efficiency, experience-centred and good design resonated through the conversations strongly. However, two primary issues were raised more specifically that present greater challenges.

Safety and security

The threat of terrorism has driven an increasing demand for the safety of large public venues, with stadia an identified primary target for extremists. The arrival of COVID-19 has now added a health threat for large gatherings to further complicate matters for venue operators. The ability to smoothly accommodate patrons and enhance the event experience arguably lies in conflict with the safety and security precautions, requiring a considered balance. The ever-evolving nature of both threats is an identified issue for most of the interviewees given the dynamic nature of these hazards.

Security used to be a simple high-level bag check aimed to identify weapons such as explosives, knives, guns etc., as well as perhaps glass and alcohol. While this challenge remains paramount and constantly evolving, the advent of terrorism incidents around the world in recent years, for example using vehicles as weapons, has broadened the security threat impacting on the arrival at the precinct, in addition to the stadium.

On event days, stadia are increasingly part of a precinct experience whereby the fan interaction starts as they approach the venue, engaging with nearby businesses, venues, merchandising and the like. Security protection for the precinct is typically through road closures, barriers and bollards, with CCTV and security and police personnel aimed at minimising the risk, and enhancing the feeling of safety for the patrons. The solutions are often operable

or make provision for temporary overlays to allow the solution to be minimised and tailored for any event, size of crowd and particular threat. The concern for stadia operators is the changing expectations and the evolving security threat. Stadia operators must remain ever vigilant, monitoring the terrorism threats and actions carried out globally and indeed the corresponding security responses, to ensure best practice is always maintained. Coupled with this challenge is the realisation that getting it wrong could cause significant harm to the patrons attending with death and injury outcomes feasible, in addition to the less critical but still damaging loss of stadia brand and reputation, revenue, events, employment, economic activity and the like.

As patrons move into the stadia, the next security bottleneck is the bag check on arrival. With fans often arriving late to venues immediately prior to an event starting time, the fast processing of security checks is paramount. Spectators have grown accustomed to arriving late and have an expectation that they will not miss any of the event, so moving fans from the precinct into their seats is a key aspect of a successful event.

During the event, security threats remain as patrons interact and their moods can swing based on their team's performance, the weather and often their alcohol consumption. CCTV and the regular and visible presence of security and police is typically a primary control, in addition to a low tolerance for aggression, language, racism and so on.

Figure 6 – Stadium security and managing crowd behaviour

Through 2020 the health threat in the form of COVID-19 has crippled the sports and entertainment industry. As venues and sporting competitions start returning to normal operations, the question of what is the new normal has raised its head. Sporting events being held to a purely television audience with no crowds in attendance have been the first step on the road to recovery; however, this isn't a sustainable model for venues with 50 000+ seats sitting vacant. Operators will need to define a new health screening overlay to satisfy fans that attendance is safe and to re-engage with the event-day experience. Stadia competing to get fans to the events against at-home viewing just got harder.

The resonance of both security and health in the interview process as a key issue, led to this forming the subsequent focus of the research paper, discussed in more detail in this paper.

Environmental sustainability

Climate change is an accepted science and the drive for operating venues in a considerate manner fostering sustainable outcomes was a repeated challenge through the interview process. Stadia by their nature have vast thresholds between a capacity event and the regular day-to-day occupancy. While the flexibility

and ability to have the venues operating efficiently 365 days a year is ever present, the fundamental truth is that the venues will not be at full capacity often during a calendar year and, as such, the environmental impact and costs of venues requires more thought. Efficient design at the outset is clearly fundamental with good engineering systems and passive design allowing for reduced impact. Stadia are also getting better at engaging with their surrounding precinct and neighbours to identify shared environmental outcomes. For example, stadia typically command vast land areas and significant roof coverage, hence stormwater harvesting and solar energy collection to support the broader precinct between primary events are emerging as successful outcomes.

A key sustainability imperative for operators and venues is the function that stadia can have as a role model to the community with regard to environmental outcomes. Stadia are major tenants in a city and attract attention, so a well-designed stadium with efficient and well-publicised sustainability performances can influence operators across the city, as well as reinforce their own brand. All initiatives that drive up the venues attractiveness with potential customers, while driving down costs, must be viewed positively beyond the altruistic view to the environment.

Figure 7 – Weser Stadium, Bremen, Germany – 6000m² or 200 000 photovoltaic cells cover the 40 000 seat stadium roof

Question 3. How could engineering design better support you in stadia design and operation?

Throughout all interviews, the value of the engineering profession in the design process was clear and indeed a collaborative team-focused relationship was emphasised repeatedly. Engineering needs to work in tandem with architecture to derive design solutions that are comprehensively tested with operators and key stakeholders, then interfaced with contractors to ensure they can be constructed safely, efficiently and cost- effectively. The modern stadia design is presented with enormous challenges to remain valid as described within this paper; however, the challenge isn't so much the technical aspect but the human-centred factors that often define stadia success.

Technical challenges within the stadium design field are generally well-defined – venue sight lines, egress times and approaches, fire evacuation, structural stability, stormwater design and management and the like, evolved over time into a set of generally agreed parameters, but how these designs interact to create the intrinsic value of a stadium is less tangible. Experience-based design and looking at the fans, at all levels, and how they interact with the venue is key. Engineers must be open-minded to how the stadia operates, they must listen and adapt

to the information that is provided by operators and stakeholders and incorporate these features into the design. Experience in stadia design is advantageous if not essential; however, this is also balanced by having the agility and flexibility to design according to the evolving stadia experience and requirements. Time is a clear issue to create the best designs, but the value in a better planned and organised stadium design cannot be undervalued. The ability to get it right is easiest with the right planning at the outset.

In the category of 'iconic', stadia give architects and engineers more scope for design and artistic expression than most other building typologies. Elegant structural solutions for long span roofs, column free function areas, retractable and operable roof forms and so on, provide plenty of engineering challenges for the structural focus. The ever-increasing advent of technology into venues has reinvigorated specialist lighting, audiovisual and immersive technologies to drive the fan experience, allowing for real time feedback and interaction with the event, branding and advertising. Passive designs for maintaining the comfort of patrons and even air conditioning stadia venues, such as proposed for the Qatar World Cup in 2022, are always raising the bar of the design challenge, and always with the aim to promote physical attendance through offering an immersive and comfortable experience at the event.

Figure 8 – Iconic stadium design – Wembley Stadium, United Kingdom

Question 4. What do you see as the biggest lost opportunity in stadia design that if unlocked would create the most benefit?

Lost opportunities are often difficult to define and this question prompted some pause in response. Interviewees referred back to the definitions of success, reciting the flexibility demands, as a key opportunity that has been missed. Retrospective upgrades or modifications to stadia, while accepted, were identified as lost opportunities. Upgrades often included changes in the fan offerings with, for example, seating changed from general admission to sit/stand offerings, to more fundamental modifications to support back of house. A conversation about the requirements for staff changing facilities and lockers for the myriad staff that access all levels of a stadia event included an unusual example: lacking these facilities, key floor area had to be repurposed to suit with the loss of area in the back of house offering detracting from more popular fan-based, and revenue-raising opportunities.

A key lament is heard when the stadia design basics are simply not met. Accepting that the technical criteria are typically well-defined, that does not of itself void the possibilities of lost design opportunities, reinforcing the need for a comprehensive and robust stakeholder management process and user consultation. Designers must engage with venue operators, clubs, maintenance, security, catering and the myriad other affected stakeholders and then create a delicate balance to satisfy these many masters. It was clear that the design process needs time to support these iterations, which are further enhanced with the early involvement of the contractor, to ensure the design can achieve these ambitions while maintaining a constructible solution that ultimately is still delivered on time and on budget.

The lost opportunity of truly integrating the stadia design into the greater precinct is something which also resonated with many of the interviewees. It is vital that the stadium faces both inwards and outwards, and can operate outside of main events and enhance the greater community offering. While the stadium has morphed into having a better connection with the outside precinct, it is clear that the retrospective master planning of some venues is a lost opportunity compared with a truly integrated plan from the outset. Such an example is Marvel Stadium in Melbourne where the original stadium was built in isolation of any greater precinct which, after the passage of time, created a more vibrant commercial and retail precinct. It is an example in point that, while the outcome has proven successful, the implementation has been a lost opportunity in the context of how that work has been staged.

Figure 9 – Marvel Stadium Melbourne (then Colonial Stadium) – isolated and on its own

Figure 10 – Marvel Stadium Melbourne – morphed into an integrated and activated precinct

Another lost opportunity, or future opportunity, is for a stadium to be the benchmark for sustainable design going forward. Stadia sites represent large parcels of land in key city locations and create an atmosphere and engagement with the greater community, which enables them to be a role model in the way that they approach their energy and material usage. Examples such as photovoltaics on the roof, retention and reuse of stormwater and other passive design systems simply must be integrated into future stadia. Allowing for a connection with the greater precinct, enables that retained energy and material used to be utilised successfully outside of event day for a net community outcome.

Question 5. What do you see as the future of stadium design and the stadium experience?

The future was generally accepted by the interviewees as the continual improvement of the stadia design and operation to capture the themes discussed – how to get a stronger attendance and better fan experience, how to improve the stadia commercial model by driving up revenue while decreasing costs, and how to integrate the emerging technologies to facilitate both aims.

Figure 11 – Stadium ribbon LED signage engaging sponsors and event branding

The stadia experience is paramount and resonated strongly through the interviews. Stadia operators are trying to find new and better ways to engage the fan at all levels, of all generations, all price points, singles and families, young and old, local and tourist, to improve the overall experience. The integration with the precinct is a key method to improve the experience with the flow-on benefits to decrease peak demands on arrivals and departures by smoothing the timing and duration of attendances.

The impact of technology is a key opportunity and area for the next stadia to differ from the last. Immersive technology, 5G, augmented reality and access to information will play a future part of the match-day experience. Even today, the fan can watch a replay on their mobile device while at the game and have access to real-time statistical data. The fan of tomorrow will likely have the ability to choose their viewing angles, adjust the commentary heard and be able to have a player's or umpire's view directly on their smart device. This is a double-edged sword though, as these technologies will be available away from the venue as well, so the direct connection at the venue must stay paramount. People are social beings, therefore the theme of 'you had to be there' must retain value.

Security and safety is perhaps the aspect of stadia design and operation most subject to change. The evolving threat of physical harm and terrorism has long been on the mind of the stadia industry, but the emergence of COVID-19 has had a profound impact. 2020 will go down as one of the most difficult in the sport and event industry with all sporting and cultural events and competitions halted for months as coronavirus swept the globe. As restrictions are gradually relaxed by some jurisdictions through late 2020 with others to follow, events are being planned and gradually restarted. However, the new normal starts without the crowds, or with partial capacity crowds, without the revenue and without the atmosphere and energy on which the match-day experience so heavily relies. As a search for a vaccine continues the reality of the new normal continues to evolve; however, change is afoot. On this basis, the author's paper will now concentrate on the security and health impact of the future stadium as the key focus themes of the research paper.

Stadium health

4 Stadium health

4.1 Health threats

4.1.1 COVID-19

The advent of the COVID-19 pandemic has thrown the sports and entertainment industry into turmoil with most venues and events cancelled at short notice. While the pandemic continues to wreak havoc around the world, there have been the early stages of a return to operation in some districts; a return to the 'new normal' as it is so often called, is underway.

In effect, there have been five stages:

1. Stadia operations pre-2020 – high attendance events with a focus on the spectator experience as highlighted through this paper, active encouragement of crowds and atmosphere.

2. COVID-19 closures – early to late 2020 – widespread closure of stadia almost overnight with cancellation of all events, large crowds or otherwise.

As the government restrictions and social distancing regain some level of control over the coronavirus, a further three stage recovery has commenced:

3. Virtual events – under tight hygiene and health and safety protocols sporting events have recommenced without the crowds catering for a television audience alone.

4. Partial attendance – venues in various parts of the world have started to move to partial capacities in the order of 25–50% of the total capacity, in line with social distancing requirements in the relevant jurisdictions. Capacities will be a function of social distancing while seated, in addition to circulation in the concourse and aisles, as well as arrival and departure points.

5. Full attendance – as the virus is overcome, and potentially when effective mass vaccination is established, stadia will be looking to return to normal capacities, or maximised capacities, to restore the industry.

Figure 12 – Professional Sports in front of empty seats due to COVID-19 became the norm

The advent of COVID-19 throughout all aspects of life has demanded flexibility and agility in the population generally, and the world of stadia and events has been impacted more than most. The response to COVID-19 is underway and although a vaccine promises a desirable outcome, the operation of stadia will be forever changed. The interim response to COVID-19 pending any vaccination also offers some level of insurance for future pandemics keeping in mind that COVID-19, while unique, is not isolated and within the past 100 years several significant pandemics have arisen (20 of the Worst Epidemics and Pandemics in History | Live Science):

- Spanish Flu: 1918–1920; 100 000 000 deaths

- Asian Flu: 1957–1958; 1 100 000 deaths

- AIDS pandemic and epidemic: 1981–present day; 35 000 000 deaths

- H1N1 Swine Flu pandemic: 2009–2010; 151 000–575 000 deaths

- West African Ebola epidemic: 2014–2016; 11 000 deaths

- COVID-19: 2020–present day; 1 020 000 deaths to October 2020

It appears likely given the prominence of COVID-19 in the media and public gaze, that the awareness of pandemics as a concept has grown and stadia will need to respond to the heightened health and safety awareness of the public irrespective of any coronavirus vaccine. The public demand for high hygiene will remain post COVID-19 as new habits or insurances against the next pandemic, whatever and whenever that may be.

4.1.2 The new normal

Paramount to achieving any form of new normal, that is a new operating model and behaviour, in society involves consideration of the behaviours and experiences of the stakeholders involved. In this aspect, stadia and event operations should be well-prepared as the design and operation of stadia has long focused on the experience, and how to positively impact and influence that experience to promote attendance and revenue. The response to COVID-19 should similarly look to an experience and behavioural aspect initially to regain the ground lost during the initial phases of the pandemic and in time look towards a brighter future. For many in the community, the ability to be part of the crowd, to feel the atmosphere, to witness sporting and entertainment at the highest level are parts of what makes life worthwhile and will signify a return to the new normal.

The solution needs to therefore look at behavioural aspects of stakeholder interactions, as well as processes and operational guidelines and new and adapted physical infrastructure and plant. Gaining the trust and confidence of the stakeholders will be vital and the changes introduced by COVID-19 also offer some opportunities to improve the overall experience, a unique opportunity that shouldn't be wasted.

4.2 Potential design solutions

4.2.1 Introduction

For the purposes of explaining possible mitigations for COVID-19, the 5E methodology will be used (Customer Journey Map: The 5Es Framework – Lewis C. Lin) that tracks the interaction of the stadia and event operators with their key stakeholders – the patrons, sponsors, players and performers, operators and owners. The solution is akin to a journey map of the stakeholder experience through all interactions with the stadium or event, door to door.

The solution to re-energising the stadia industry lies in a whole-of-life approach through the following five stages:

ENTICE: How the stakeholder is attracted to and informed of the stadia or event

ENTER: How the stakeholder begins dealing with the stadium or event

ENGAGE: The experience at the stadium or event

EXIT: What the stakeholder leaves with after the event

EXTEND: How to follow up with stakeholders to encourage a future return

As a stadia operator or event organiser not all phases are under their direct control, so collaboration with other parties to influence is important for a successful series of solutions. Agility and flexibility will also be demanded as the solutions are highly likely to iterate to the new normal.

4.2.2 Entice

Generally the stakeholders that traditionally attended stadia and events remain the target audience of the stadia operators and event organisers into the future. Some of that group will be apprehensive to return after months of social distancing and hygiene messaging changing everyday habits and expectations. To regain the trust of this group will be paramount so they are comfortable to attend the stadium and take their friends and family, confident that their health and well-being is not at risk. At the other end of the spectrum, will be the sceptics of the coronavirus who view the pandemic as a highly inconvenient overreaction, and will be fearful of stadium experience layered with long queues and unnecessary process detracting from the 'good old days' attending the stadium. As with all interactions with the public, there will be a range of views to be catered for. Pleasing everyone will be the target but almost certainly unachievable.

Paramount will be a close interaction of the stadium operators and event organisers with the local government, police and health authority advice. Ground capacities can be expected to vary at short notice, particularly in the case of any flare ups in confirmed diagnosis, especially in the short to medium term.

In the initial return with partial crowd attendances, ticketing and sharing the experience with potential spectators addresses the first challenge and is a useful testing ground as crowd numbers grow. A ballot or first-in-first-served method likely is enough to support low occupancy limits within large venues. The first tentative steps back also offer a means to reward the club members and season ticket holders, who have in many cases maintained their support of the team or venue during the shutdown period. The low capacity crowds are also useful ways to gradually implement changes in procedures for stadia staff in preparation for larger, then capacity, crowds ahead.

As crowds grow, there will likely need to be some competitive pricing to entice fans back when ticket allocations start to exceed initial demand. During the virtual event stage, typically spectators were forced to engage through the broadcasters at home. In some cases, people will likely have found a happy equilibrium with the creature comforts of home viewing, coupled with a perceived improved health and safety outcome that comes with avoiding the crowd. Television sales and home entertainment sales have increased approximately 50% compared with past years, as people have enhanced their lock-down experiences. The battle of ground attendance to home broadcasting has been a challenge to stadium operators for a long time with COVID-19 providing a forced reconciliation for a period. It is likely that some will need to be convinced that the venue is safe and a preferred experience over the home viewing experience, but this can always be reinforced by a lower attendance cost, at least initially, to restore attendance numbers.

The education and promotion of health expectations and changes needs to be visible to garner the trust of the community to attend, but also to support the successful daily operation. Attendees to the stadium need to be personally accountable and incentivised to cooperate with necessary health directives. The public must be encouraged to self-isolate or at least not attend if unwell or displaying potential COVID-19 symptoms, when perhaps they may have battled through in past years. Consideration to credit or refunds on ticket prices or ticket exchanges should be provided to further facilitate non-attendance and encourage responsible behaviour of all. In theory, this should match the general public expectation; however, education remains key.

A long-term effect of COVID-19 will be on the construction of new venues. It is likely that until the vaccination programmes are proven to be effective the business models for new stadia will be difficult to justify, particularly while the coronavirus response is being formulated and crowds grow in confidence to return to venues.

Refurbishment of venues to support social distancing and improved hygiene requirements will be likely with associated reduction in ground capacities to support the greater spaces required. This does offer the opportunity for a higher premium experience, which may attract a higher revenue per capita to offset the reduced crowd numbers, but the implications of COVID-19 long term are as yet undefined.

4.2.3 Enter

Having enticed the people to want to attend, the arrival experience for spectators, players and performers, staff and officials will likely be forever changed. Social distancing works entirely against the current arrival experience at most stadia especially for large crowd events. As soon as a stakeholder leaves their home, the experience needs to adapt to the new normal.

Stadia operators and event organisers will need to collaborate with government and public transport officials. As per the earlier parts of this paper, arrival by public transport is the preferred method of transit for most spectators and indeed the preferred crowd arrival mode for stadia operators. The ability to efficiently move large numbers of people to a localised stadium is best facilitated by bus and train, yet bike and car transit would be a better COVID-19 solution. Public transport is going through its own transition to a new normal with contactless entry, exit and payments, face masks and increased cleaning regimes; however, after high capacity events the likelihood of 1.5 m between patrons is effectively zero. Doubtless transport will need to be closely controlled with additional services to facilitate a lower population density, coupled with a likelihood of greater private transport. In all probability, in a post-COVID-19 world that the entry and exit experience will take longer, detracting from many people's experience.

Figure 13 – The public transport systems post-COVID-19

The pre-game experience has been growing in recent years as a way to enhance and extend the match-day experience. It is likely that this can be used to advantage to deal with social distancing by spreading arrival times of the spectators and reducing the peak demand on public transport infrastructure. In the precinct around the stadium, the pre-game facilities will need to be redesigned to facilitate greater space between food and drink outlets, merchandising and sponsor tents and the like, spaced further apart with wide aisles to allow for suitable movements. Crowd density will also need to be monitored by event-day security and staff.

A potential solution to reduce crowds will be to also incentivise patrons to enter the ground at various times before the event in a form of timed ticketing – social distancing will be impossible if the full crowd moves to their seats in the minutes before kick-off, so increased pre-event entertainment within the stadium to attract people to their seats earlier would be advantageous. The return of the warm-up game or reserves could be a solution.

Contactless operations throughout the day are a near certainty into the future and indeed, in many cases, relatively common before the pandemic. Ticketless or contactless arrivals through mobile devices will become the norm with contactless arrival turnstiles. Temperature checks as part of a security arrival will become a likely arrival process, with high-temperature guests likely to be asked to leave or be subject to further assessment. The temperature checks could be undertaken with the hand held devices; however, a faster entry experience may be present with screening equipment which may evolve in response to the pandemic. This health screening will also necessitate additional medical staff and facilities. In addition, potential tension and push back from unhappy spectators will need to be accommodated – enhancing the need for education and incentives to encourage unwell patrons to stay away. It is also likely that bagless arrival will be further encouraged to minimise physical contact with security checks that are delicately balanced with health considerations.

Figure 14 – COVID-19 temperature checks are a likely requirement on a capacity stadium arrival

The use of PPE and hygiene stations at arrival points will become second nature. Many venues will have staff uniformed to include protective gloves and masks, and some may extend that to arriving patrons pending the government restrictions in play. There may be cases for disinfecting sprays or arches for patrons to pass through as they arrive as a way of both visible and hopefully highly effective decontamination measures.

4.2.4 Engage

The match-day experience will differ significantly post-COVID-19 with the adherence of a strong emphasis on social distancing and contactless interactions. Having arrived by digital ticketing, all purchases inside the stadium will be contactless with cash payments unavailable. Merchandising and food and beverage outlets will likely be retrofitted with clear screens to limit transmission to staff. Toilets and amenities will need to be redesigned for contactless doors either through remote access or, at worst, foot controlled with all internal toilet flushes, soap dispensers and hand basins contactless. Dedicated entry and arrival areas and one-way access through outlets and the greater stadium will be commonplace.

The most successful method for maintaining social distancing for patrons at the stadium will be while seated. Standing areas will be restricted and stadium operators will focus on ways to move patrons into their seats to reduce congestion in corridors and aisles, in addition to food and beverage, toilets and so on. There is likely to be an increased science potential for maximising crowd capacities to suit social distant seating, which is an opportunity for further research beyond the scope of this paper. Typically, alternate seating will be adopted; however, with programming, the consideration of clusters of people from the same households sitting together to improve ground capacity is possible. Within the document Planning for Social Distancing at Sports Grounds (SG02 Planning for Social Distancing at Sports Grounds – Sports Grounds Safety AuthoritySports Grounds Safety Authority) examples are provided for different seating configurations depending on the required socially distant perimeter for various group sizes in a typical seating bay, such as depicted in Figure 18 and Figure 19 respectively. As per the two examples depicted, the variables in setting the seating configuration could be defined to maximise attendances. Parametric modelling to maximise crowd numbers presents an interesting opportunity to explore further beyond the scope of this paper.
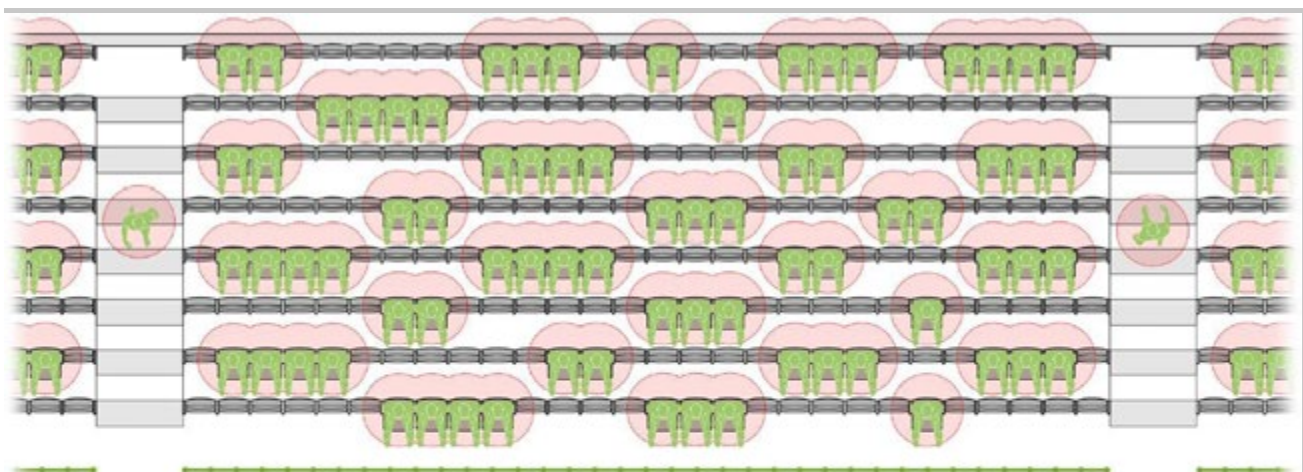
Method One: Example 1 (above)
Dimensions: Seat row depths: 700mm / seat widths: 460mm / radial gangway widths: 1.2m
Seat allocation: Every row occupied, in singles, twos, threes and fours
Social distancing requirements: Two seats must be kept unoccupied between every allocated seat. Every seat next to radial gangways must be kept unoccupied. One-way flow only possible in radial gangways at any one time. **Occupancy level:** 75 seats out of 224 (approx 33 per cent)

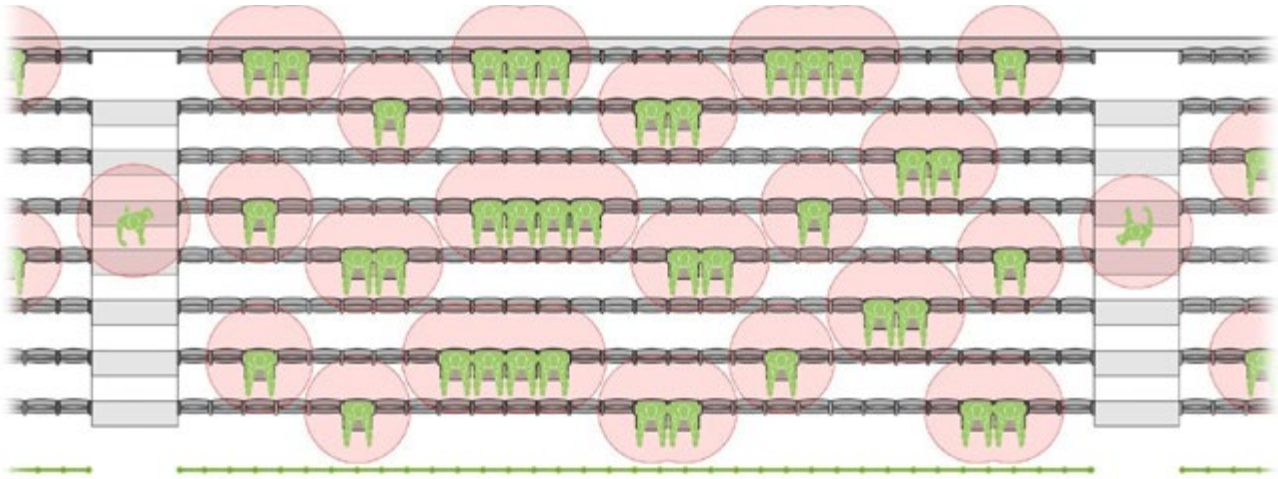Figure 15 – Socially distant seating configuration – every row occupied

Method Two: Example 1 (above)
Dimensions: Seat row depths: 700mm / seat widths: 460mm / radial gangway widths: 1.2m
Seat allocation: Every row occupied, in singles, twos, threes and fours
Social distancing requirements: Two seats must be kept unoccupied between every allocated seat in the rows both in front and behind. Two seats next to radial gangways must be kept unoccupied. One-way flow only possible in radial gangways at any one time.
Occupancy level: 38 seats out of 224 (approx 17 per cent)

Figure 16 – Socially distant seating configuration – alternate rows

The stadium will need to revise entirely the cleaning protocols with cleaning between events enhanced, and potential for replacement of materials and surfaces to easier clean surfaces to further limit contagion. To enhance public confidence the cleaning should be visible so, while discrete without reducing amenity, the ability for the public to have visibility on enhanced hygiene protocols is advantageous.

The stadium circulation will need to be revitalised with one way access preferred through aisles. In some cases, this may entail modifications to seating to make more space with removal of seating rows or reduction in food and beverage stations to allow for the increased space required. Wayfinding and digital directions will need to be enhanced to more efficiently move people to their seats with a minimum of fuss, with floor markings in place to emphasise separation. It is also likely that access within the stadium will be restricted with entry gates, toilets and food and beverage stalls tied to your seating area to prevent unnecessary interactions and minimise circulation. Standing areas will be limited or eliminated in favour of the greater control of fixed seating. There may be a likelihood for food and beverage ordered digitally from a mobile phone with in-seat delivery to minimise crowd movements that may improve spectator experience and offer something new to offset the change in the match-day experience.

Engineering solutions to minimise the contagion of COVID-19 will evolve. Initially, mechanical systems will be reinforced for higher air-exchange rates and filtration to minimise airborne contamination and the introduction of UV-A and UV-C lighting to sterilise high contact areas, such as bathrooms and food and beverage areas, will be developed and introduced.
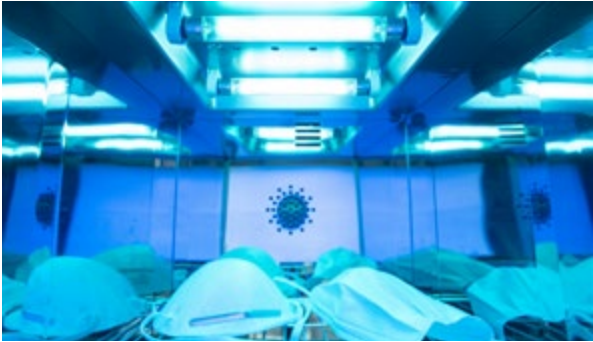
Figure 17 – UV light could be part of the solution

Training for staff will be extensive in both their hygiene protocols for their work, in addition to training for monitoring and controlling the public interactions.

Throughout these changes, although challenging, maintaining a normal experience at the stadium is paramount. People are social beings and they yearn to interact again but maintaining the safety and health of all persons at the stadium, whether they be staff, public or players must be front of mind. Preventing flare ups in COVID-19 numbers is a societal responsibility, but given the strong emphasis that community confidence and trust has in an operating and sustainable stadium, the damage to the brand would be extensive akin to the holiday cruise market impacts at the outset of the pandemic with the Ruby Princess, a highlighted Australian example.

4.2.5 Exit

The greatest crowd densities occur after the event or match is completed when the crowd all seek to get home. Crowds of people choose to leave early to beat the traffic and very few linger after the event, so maintaining a socially distant environment at this time will be the most challenging.

Consideration to providing after-event catering and entertainment to try to spread the crowd movements over a longer duration will likely need to be considered, potentially coupled with a revenue increase to further incentivise. Staggered seating bay departure is another option, albeit it could pose interesting crowd control measures and feedback from those patrons unhappy at their departure being delayed.

In an infrastructure sense, consideration of methods to open up the exits more effectively to facilitate the large crowds will be valuable. The traditional stadium allows for all emergency exists to be opened at the completion of an event; however, the ability to further facilitate exits would be valuable.

The cleaning and hygiene requirements for the venue after the event will also grow with a far higher and more thorough cleaning operation required.

Figure 18 – Post-event cleaning will be greater and more important than ever

4.2.6 Extend

In the extend sense, the ambition is to complete the experience and leave patrons wanting to return. As the safety protocols, procedures and behaviours evolve, post-event feedback and surveys would be worthwhile to garner an understanding of the patron experience and where improvements can be made.

Contact tracing would also be a valuable process in the event of a subsequent positive diagnosis to inform patrons in close proximity of an infected person and limit pre-symptomatic transmission. With tighter controls on standing areas and a greater emphasis on fixed seating, at least in the short-term, contact tracing through ticket sales should be available to stadium operators should the need arise.

Reinforcing the trust of the attendees and emphasising the protocols and experiences that they saw and enjoyed is paramount, as is the ability to improve any shortcomings and adjust to a dynamic environment. Maintaining trust for a return visit is paramount.

4.3 The way forward

It is clear that, as the stadium and event industry returns to normal, agility will be required. COVID-19 has disrupted most elements of society through 2020 and, while there is light ahead, it is likely that there will be bumps along the way. Gaining the trust of the stakeholders and making them feel comfortable and enthusiastic to attend the stadium or event is key, while maximising the experience that got them there in a safe and sustainable manner.

Flexibility in event programming, stadium operations and staffing, as well as managing public expectations and behaviours, will be an ongoing challenge.

There will be a demand to review and modify existing stadia to support COVID-19 protocols and find ways to drive stadium attendances to a maximum level and restore the industry. Design solutions will vary between minor works such as wayfinding, contactless doors and infrastructure to improved services infrastructure such as ultraviolet lights and better air conditioning and air filtration systems, and temperature scanning.

The importance of community vaccination is an emerging trend in future stadia management. Most governments appear to be striving for a 70-80% full vaccination rate with varying levels of compliance and urgency amongst the community. The production of a vaccination passport is under consideration for many venues with the ability to vet attendance to those fully vaccinated. Other governments are steering away from vaccination passports where community vaccination rates exceed the targets that the health infrastructure can support. What is clear is the response of stadia and event management will need to remain agile for some time in the response to the pandemic with different jurisdictions likely to have different regulations.

4.4 Further research

There is scope for this research paper to be continued beyond the investigations reported herein with regard to the COVID-19 response. Engineered solutions to assist with COVID-19 are probably part of the solution with the most promising opportunities appearing to be around mechanical engineering in the design, air flow rates, filtration for air conditioning and passive ventilation systems, together with electrical engineering for the use of ultraviolet light for real-time disinfection of surfaces, particularly in high occupancy areas. Thermal scanning on arrival could be revolutionised; more akin to science fiction to enable larger crowds to quickly enter. Hydraulic design solutions around improved tapware, soap dispensers and hand drying facilities also will form a definitive part of the pandemic solution, albeit these technologies appear well-established in the market, with the predominate challenge to stadium operations being an upgrade in selections.

Parametric modelling to define seating configurations to maximise crowd attendance, while satisfying social distancing presents an opportunity. The event experience for attendees' safety could be an exciting opportunity that could have definitive appeal to stadium operators but also, conceivably, could be extended to other environments such as theatres, cinemas, concerts and other places of large crowd gatherings, while coronavirus restrictions remain in place.
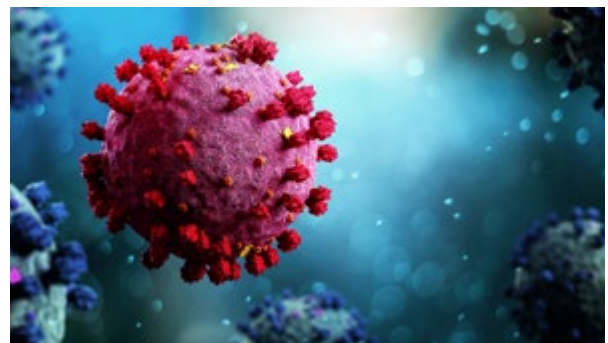

Figure 19 – COVID-19 – one of the biggest disruptors to stadium and event operations ever

Stadium security

5 Stadium security

5.1 Security threats

5.1.1 Introduction

Referring to Australia's Strategy for Protecting Crowded Places from Terrorism 2017, it is clear Australia is not immune from terrorist activities that represent the worst-case security threat for stadium and large events that attract large crowds. The Australian Security Intelligence Organisation (ASIO) has assessed the current National Terrorism Threat Level in Australia to be PROBABLE (Figure 23), as outlined on www.nationalsecurity.gov.au .

CERTAIN – terrorist attack is underway or has occurred

EXPECTED – terrorist attack is imminent

PROBABLE – terrorist attack is likely

POSSIBLE – terrorist attack could occur

NOT EXPECTED – terrorist attack is not expected

Figure 20 – National Terrorism Threat Level (Australia's Strategy for Protecting Crowded Places from Terrorism 2017)

Australia's National Terrorism Threat Level remains PROBABLE. This reflects the advice of the ASIO that individuals and groups continue to possess the intent and capability to conduct a terrorist attack in Australia. This includes threats to members of the public and locations where large crowds gather. The threat is not confined to any one city. Stadia are at risk and represent one of the largest and most easily predicted gatherings of large crowds that could be targeted by an extremist group.

Given the relatively secure level of Australia, the probable threat assessment would be replicated or worsened for most major stadia across the globe. The threat is real and the design and operations must be robust to reduce the likelihood of incidence, and reduce the consequence, but also be able to facilitate a rapid response if, or when, an incident does occur.

Having a robust, effective and trusted security approach is critical for any stadia both for the moral and ethical obligation to preserve health and safety of patrons and staff, but also to sustain the stadia brand and reputation in order to maintain a viable event schedule, attendance and business case. A significant security incident simply could cripple any stadium from future viability.

5.1.2 Terrorism

Stadia have long been a focus for extremist groups with an unfortunate history of significant events. Large crowds with an extensive television audience provide an opportunity for the misguided to introduce significant physical harm to a large number of innocent people, coupled with high profile media coverage providing publicity for extremists' views and causes. The large scale also makes security measures complex to design and administrate, offering potential weaknesses that can be sought to be exploited. The challenge for stadia designers and operators is to remain one step ahead of terrorists, vandals and those with anti-social tendencies. They need to create a robust and low-risk environment to deal with extreme events and, importantly, have measures in place to respond quickly and efficiently if, or likely when, an incident does occur. This was a major resonating theme from the interview process as a key issue that keeps the industry awake at night.

Terrorism comes in many forms:

- Weapons – the carrying and use of guns, knives and other implements to cause harm generally to a small group

- Personal explosive devices – bombs carried on the body or bag of a terrorist to cause harm to a larger group

- Hostile vehicles – using cars, trucks and the like as a battering ram to inflict harm on gathered crowds typically outside the venue

- Arson – deliberate lighting of fires

- Shooters – active shooter firing into a crowd

Security design and mitigation is effectively a risk management exercise that follows a structured and reasoned risk management approach. Terrorism threats are generally of very low likelihood; however, the very high consequences demand a high degree of attention for stadium designers and operators.

Security risk assessment within Australia is generally undertaken using the 'AS/NZS ISO 31000:2018 Risk Management – Guidelines' (RMG). The security risk assessments naturally concentrate on the stadium itself, but as per the discussions in this paper, with stadia engaging more broadly within their precincts, security concerns extend beyond the stadium walls into the precinct and public transport networks that support them.

The RMG direct the risks assessment exercise to be undertaken as follows:

- Communication and consultation
- Scope, context and criteria
- Risk evaluation
- Risk treatment

Risks are typically categorised under the following risk categories:

- Offences against property
- Offences against the person
- Trespass and unauthorised access
- Arson
- Terrorism

There is a wide range of measures in place in various extents across stadia globally to address these risks, which include:

- Closed circuit television (CCTV) system, higher resolution at specific areas
- Electronic access control and alarm system (EACAS)
- Duress alarm functionality
- Physical security elements including walls, doors, airlocks, fences, gates, security-rated bollards, assessed landscaping etc.
- Security lighting
- Staff and patron screening on event days
- Staff and contractor security vetting
- Crime prevention through environmental design (CPTED)
- Signage for reminding patrons/staff to secure valuables
- Signage for notice of surveillance in all areas and site conditions of entry
- Police and security attendance to events
- Event specific risk assessment and coordination with local police and counter terrorism
- Contracted security personnel and staff with security awareness
- Effective security operating procedures
- Efficient and effective maintenance strategies
- Restricted access to car parks by vehicles and pedestrians
- Active surveillance on event days
- Design stadium to have clear sight lines
- Crowd segregation strategies.

5.1.3 Crowd behaviour

A significant aspect of stadium security relates to crowd management. The presence of hooliganism, rioting, overcrowding and the like can have devastating impacts. Inappropriate behaviours such as obscene language, racism, sexism, and bullying also detract significantly from the patron experience and must be controlled to minimise occurrence and offenders expelled and disciplined. The range of incidents a suitable security protocol must administer is large and the ability of the fundamental stadium design to form part of the defence systems is pivotal.

Beyond crowds, individuals and small groups also can pose a threat to be managed. Further sources of threat may include:

- Competing fans and supporters for rival teams

- Disaffected/bored youth

- Homeless

- Thrill or (mis)adventure seeking

- Petty criminals

- Organised groups

- Aggrieved persons (including former staff or members of the public)

- Trusted Insiders (disgruntled staff or contractors).

Figure 21 – Crowd rioting at Moses Mabhida Stadium, Durban, South Africa 2018

5.2 Potential design solutions

5.2.1 Introduction

Design solutions for security risks are perhaps the most dynamic of the criteria that a modern stadium must consider with the threat often poorly defined, and indeed tailored by the offender to circumvent any adopted solutions. Further complicating this, is the dynamic nature of the threat, which is constantly seeking vulnerabilities in the stadium security systems to exploit, meaning today's solution may not be adequate tomorrow. The flexibility demanded in security design requires the ability to respond to any events that arise around the world and prevent similar incidences occurring at your venue. The brief is ever changing.

Australia's Strategy for Protecting Crowded Places from Terrorism (2017) offers guidance to follow basic security principles in applying a layered security approach to create a level of redundancy. This is provided through complementary security measures that work to deter, detect and delay any security threat, coupled with facilitation of the response by the operators, police and security personnel. The guide includes Figure 27 below to demonstrate this layered response, which aims to provide a system security that works together stronger than the sum of its parts:
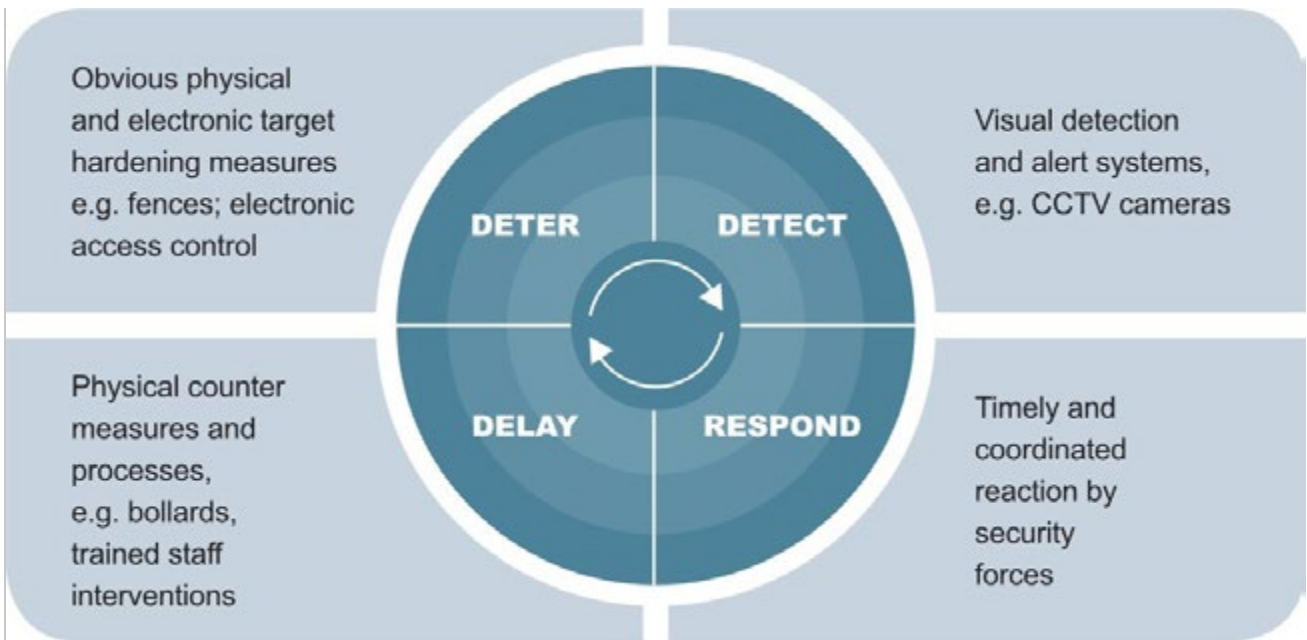

Figure 22 – Layered security (Australia's Strategy for Protecting Crowded Places from Terrorism 2017)

Examples of the security measures for each stage include:

- Deterrence measures: fencing and gates, security lighting, signage, security patrols, CCTV, bollards and barriers

- Detection measures: security alarm system, public and security personnel reporting, vehicle and bag screening, CCTV with active alarms, CCTV spot monitors

- Delay measures: fences, walls, gates, doors, landscape design and vegetation, security personnel intervention and responses, CPTED measures

- Response measures: security personnel response, emergency communications, security protocols and planning, CCTV triggered views, automatic programmed system responses on specific conditions, public address messaging.

Design solutions as proposed in (Faraji) Critical Factors Affecting Stadiums Security. Journal of Applied Security Research outline several factors:

Design solutions as proposed in (Faraji) Critical Factors Affecting Stadiums Security. Journal of Applied Security Research outline several factors:

Main factors	Sub-factors
Infrastructures	Stadium design
	Technology
Physical protection of stadium	Outer-perimeter control
	Inner-perimeter control
	Access control
	Toxic-materials control
Personnel and staff	Credentials
	Training and educating
Game planning and management	Risk management
	Communication management
	Match-day service quality
	Cultural activates

Table 1 – Security design solution factors

The design solutions can be further expanded as follows:

- Stadium design – security control rooms, screening areas, CCTV monitoring stations, holding areas, sightlines and spatial design for crowd movements, control of spectators, separation of supporters, structural integrity and robustness

- Technology – screening systems, ticketing and turnstiles, CCTV, alarms, audio visual and communications, alarms and building management systems

- Outer-perimeter control – gates and fencing, barriers and bollards, road restrictions and vehicle access

- Inner-perimeter control – security screening, ticketing and turnstiles, gates, walls and fencing, sniffing dogs

- Access control – electronic access control, locks

- Toxic-materials control – storage areas, access control, PPE, chemical storage, secure food and drink delivery and storage

- Credentials – training, prequalifications, permanent versus casual staff roles, background checks, photo identification

- Training and educating – police, security, stadium staff, emergency services personnel

- Risk management – crisis management and response, scenario modelling, emergency management plans

- Communication management – emergency services communication, public address, security command centre, CCTV

- Match-day service quality – efficient food and beverage, available amenities, good circulation, venue lighting and cleanliness

- Cultural activates – rival supporter bases, alcohol provisions, behaviour monitoring, public grievance reporting

These factors will be further discussed using the 5E model as previously described, and how the stadia design and operation can respond through the patron experience with the aim of creating a safe and secure environment, without detracting from the overall positive experience that brings the crowds to the venue in the first place.

5.2.2 Entice

In much the same way as the COVID-19 response, the Entice phase revolves around the generation and maintenance of trust of the patrons attending that the stadium or event is safe. Security is generally a more subtle reference at the Entice stage as drawing attention to the risk can sometimes cause alarm; however, a balance must be struck. It can also be argued that having a strong visible messaging of security protocols may also deter would be extremists and vandals, acknowledging that security controls are overall a closely guarded secret. The communication of primary security measures and indeed penalties that apply for breaches can act as a deterrent to inappropriate conduct.

A further area of security management is around the use of predictive data and analytics. Stadium operators must work closely with police forces and intelligence agencies to understand emerging ideologies and threats and how these may appear in stadium operation. The best security prevents the incident from arising in the first place – prevention is greater than cure – however, these approaches are inherently protected and not appropriate to discuss in this paper.

Security planning also varies depending on the event and the crowds expected. Different events have different risk profiles that may demand alternative approaches. Additionally, hooliganism can sometimes be associated with a group of spectators, so in the Entice phase, akin to a planning phase for venue operators, consideration for crowd management is also prevalent. Football (soccer) matches across the globe often have separated spectator groups to avoid clashes also extending to designated entry and exit points to further separate potentially volatile groups.

During the planning stage, stadium operators will have extensive planning to tackle with most security management plans, training and risk management processes undertaken and maintained throughout the stadium life. It is essential that these administrative controls are continuously updated and adapted to suit the risks for each event.

5.2.3 Enter

The arrival at a stadium or event is often the first time security measures are encountered albeit these measures have been in place for many years and generally well accepted. On arrival at the precinct, security controls will be present with initial vehicle management through road closures, bollards and barriers to control traffic movements and separate vehicles from the public.

The physical protection of the stadium is often evident at this stage but to varying degrees. As outlined in this paper, the ability for the stadium to operate inwards and outwards is optimal and the engagement of the greater precinct a key part of the match-day experience. The protection of the outer precinct is initially controlled through road closures that work to enhance the pedestrian-friendly nature of the area, plus limiting easy access to the inner stadium precinct. Controls typically include bollards and gates; however, as evident in recent years, the use of vehicles as weapons has 'upped the ante' for these structures and the design requirements for wilful damage are significantly more than for more likely inadvertent impacts.

Urban design solutions are present that can be better explored to provide the physical protection without excessively compromising the function or appeal of the area. The use of larger planter beds, trees and water features that obstruct access, while offering some landscaped amenity, and road design that limits straight runs are further opportunities that are explored in stadium and broader precinct designs.

Stadium branding and signage and external art and sculptures can also be designed to provide protection against vehicular impact in an unobtrusive manner that can work with the greater urban design ideologies in a more aesthetically pleasing manner, while still providing physical protection. The use of raised kerbs and stepped landscapes can also prevent vehicle ingress, while still facilitating the patron brief. These solutions can sometimes however be problematic for inner city sites, where the road networks are often long-established plus need a greater flexibility of operation between events. Stadia precincts on match day demand greater protection than in general use, so the flexibility demands increase the challenge.

Stadium car parking presents an interesting challenge for stadium operators. Convenience, particularly for staff, corporate guests and VIPs suggest car parking as close to the venue as possible, yet given the potential risk of vehicles either as a weapon in and of itself or for carrying explosive devises, infer a preference for remote parking away from critical infrastructure and people. There has been an increase in parking physically beneath stadia, even under the playing surface, however the implications of an explosive device in such locations could be catastrophic. Where these car parking solutions are adopted, increased security screening could be envisaged to offset the risk, although it would represent a higher risk overall.

The inner stadium perimeter controls are established through the stadium walls and gates in addition to security and police overlay. Entry is heavily controlled through security screening and discrete turnstiles, even though there is an increasing approach to ticketless entry as digital ticketing technologies advance that aim to facilitate faster entry for patrons. It is unlikely however that, even with ticketless approaches, security screening will ever be avoided for comparatively high security risk events and venues. There is a likelihood that digital screening technologies will infiltrate particularly the larger venues to both facilitate faster arrivals, but also offer a more efficient and effective screening process than the crude bag searches undertaken at most venues today.

The queues for the bag check on arrival is a well-established routine at sporting venues as indeed are present in many areas of life such as airports and train stations. The public acceptance and understanding of these processes is high, indeed for large venues and events it would be foreign to visit without these controls in place.

5.2.4 Engage

Once inside the stadium, the security overlay moves to largely a surveillance mode targeted around identifying potential problem areas and patrons for proactive responses. Most stadia now have extensive processes in place to control antisocial behaviours with advertising of phone numbers to call or text for reporting of inappropriate patrons throughout the full-crowd attendance. This passive surveillance is a fundamental security measure with potentially all 100 000 attendees being additional sets of eyes and ears for the security group to monitor behaviours. This passive security is very effective for identification of anti-social behaviours with patron eviction through such measures commonplace. Coupled with CCTV, venue operators also have the ability to prosecute offenders and expel them from re-attendance in more severe occurrences.

CCTV and passive surveillance is however less effective for more catastrophic events such as weapon attacks and explosive devices that often occur suddenly. Reliance on security on arrival remains the best approach for prevention, with CCTV rendered effective only for prosecution of offenders if indeed that is feasible. High definition vision of your patrons receiving harm would be the last thing most stadium operators and designers would wish to see of course.

Management plans for stadium operation would also need to be in place and understood to deal with security events ranging in scale from an unaccompanied bag or suspicious item, projectiles being thrown into the crowd or onto the playing surface, physical altercations between patrons or against staff, trespass, theft, and arson, all the way to extreme terrorist events.

Design solutions for the prevention of terrorism, or at least to minimise the effects of terrorist activities include:

- Robustness of structural design – key structural members are designed to be able to either withstand terrorist activities, most commonly explosive devices or vehicular impacts, by having sufficient strength and ductility to withstand the forces without loss of function, or by being part of a broader structural system that can mobilise alternative load paths such that progressive collapse of large areas of the structure is prevented. In most jurisdictions, this is now a mandated design condition albeit it typically still would result in some loss of life or significant harm locally, but prevent major casualties.

- Selection of materials – designing using appropriate materials is paramount. For example, an explosion adjacent to a glazed façade should not result in sharp shards of glass becoming projectiles into the unsuspecting crowd beyond, so shatter-resistant glass must be used such as laminated glazing. A similar analogy applies to other architectural finishes, so they don't inadvertently form a continuation of the explosive payload.

Figure 23 – Laminated glass to minimise secondary damage from glass shards caused by primary impact

- Access security – within a stadium there are areas that must be protected from patrons seeking to undertake terrorist or antisocial activities. Building management systems are designed to control door access and locks, with high security facilities usually hidden in the bowels of the stadium. Stadium security often prefer positions where natural vision is possible of a crowd, although the advent of CCTV has largely facilitated security occupying less prominent, and ultimately valuable areas of a stadium for patrons, being used. Access must also be controlled to any hazardous storage areas, cash rooms and safes, corporate and VIP areas, back of house and staff rooms etc.

- Crime prevention through environmental design (CPTED) – improved sightlines for surveillance, avoiding blind spots, easy access and wayfinding, walls and barriers of suitable height, width and strength, designing to prevent climbing or jumping

- Technology design – CCTV systems potentially with facial recognition, alarms and distress management systems, communications systems, audiovisual and public address. Technology design solutions are constantly evolving and generally easier to implement as an upgrade to an existing stadium so present significant scope for security enhancements

5.2.5 Exit

After the event has finished, the typical role of security is more focused on crowd management with large volumes of people heading home, often in a far smaller time window than arrival. Typically, there is a heavy police and security presence at these times to control pedestrian movements and facilitate traffic where possible, including road closures and manned people-traffic management. Security threats from terrorism are typically lower at this stage and the use of vehicles as weapons would be the exception.

5.2.6 Extend

The Extend process revolves around a critical analysis of the event operations and how the security performed. Stadium operators look critically at how the event was run and look to fine tune after each event. Should a significant incident occur, this introspective analysis grows exponentially depending on the occurrence.

Externally the stadium needs to engage with the attendees, especially in the case where a security threat, significant or minor, occurs. The trust of the crowd must be maintained, so the ability for the stadium operators to reassure patrons of their safety, particularly if a threat was part realised, is paramount.

5.3 The way forward

Security design and operations are likely to remain items that keep those in the industry awake at night. The threat of terrorism remains, while ongoing antisocial behaviours of the crowd occur in most events, particularly with the addition of alcohol. The conflict between preventing or mitigating such events and the desire to enhance the general event-day experience remains ever present.

Design solutions from an infrastructure viewpoint are an opportunity to further reduce the security risk profile of a stadium which, when done cleverly, can be ingrained into the design without detracting from the experience.

5.4 Further research

Further research into stadium security beyond the scope of the author's research paper is possible, particularly for design and testing of obstructive devices for vehicular impact. Consideration of ways to integrate physical security within landscaped and urban precincts unobtrusively could be an opportunity to enhance security, while maintaining the fan experience.

Structural design for robustness in the form of prevention of progressive collapse and/or the ability to withstand explosive forces could be considered, but is typically heavily bespoke for each stadium design.

Advances in technology particularly around facial recognition closed circuit television is another area of potential development.

Conclusion

6 Conclusion

The stadium design and operation is amongst the most dynamic of all building typologies. The definition of a successful stadium will vary between different stadia, different cities, different countries, different sports and different times. Creating a guaranteed set of rules or criteria that define success is therefore not viable, so this paper aims to define the areas that require consideration. Design solutions need to remain agile as the parameters will change over a stadium's life and to remain relevant, to remain viable, stadia must be adaptable, flexible and able to evolve. Never has this been truer than in 2020, with the advent of the COVID-19 pandemic crippling the stadium and events industry requiring a flexible approach into the new normal.

Coupled with an ever-increasing terrorism threat, this paper aims to identify the design challenges from a stakeholder experience lens to assist the designer and operator interpret the criteria to best suit their stadium. The factors are immense and unpredictable, but the rewards are great with the stadium experience among life's highlights – it's what keeps the author coming back either as a designer or a spectator.

Further research beyond the scope of this paper has been outlined in Sections 4.4 and 5.4 respectively. These include the design of enhanced air conditioning and mechanical systems for increased air exchange to limit cross contamination, the use of UV lights to disinfect surfaces continually, and parametric modelling for optimising ground capacities for alternate group sizes with social distancing constraints. For security, additional works for design of physical barriers to obstruct hostile vehicles within landscaping and urban design, particularly for a flexible overlay and the design of stadia structures for elimination of progressive collapse are key opportunities.

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Bibliography

8 Bibliography

Lewis, L.C. (2016). Customer Journey Map: The 5Es Framework. Accessed Oct. 30, 2020. https://www.lewis- lin.com/blog/2016/11/11/customer-journey-map-the-5es-framework

RMIT University Library. The Designing for Growth Field Book: A Step-by-Step Project Guide. Accessed Oct.30, 2020.

https://primo-direct-apac.hosted. exlibrisgroup.com/primo- explore/fulldisplay?docid=TN_cdi_askewsholts_vlebooks_9780231537087&context=PC&vid=RMITU&lang=en_US&search_scope=Books_articles_and_more&adaptor=primo_central_multiple_fe&tab=default_tab&query=any,contains,designing for growth&offset=0

Liedtka, J., et al. (2016). The Designing for Growth Field Book. doi: 10.7312/lied16467. Columbia University Press.

Sports Grounds Safety Authority. (2020). SG02 Planning for Social Distancing at Sports Grounds. Accessed Oct. 14, 2020. https://sgsa.org.uk/sg02-planning-for- social-distancing-at-sports-grounds/

RIBAJ. (2020). More Contactless Technology, More Toilets: How Stadium Design Is Adapting to Post-Covid Safety Requirements. Accessed Oct. 12, 2020.

https://www.ribaj.com/intelligence/rethink-post-pandemic-design-stadia-and-leisure-centres-populous-afl-architects-pattern-design

ProQuest. Australia's Strategy for Protecting Crowded Places from Terrorism. Accessed Sept. 20, 2020. https://search-proquest- com.ezproxy.lib.rmit.edu.au/docview/1930622052/fulltext/D6C158EA2C1F48D4PQ/1? accountid=13552

Faraji, R., et al. (2018). Critical Factors Affecting Stadiums Security. Journal of Applied Security Research, vol. 13, no. 4, Routledge, Oct. 2018, pp. 473–88, doi:10.1080/19361610.2018.1498264.

RMIT University Library. Critical Factors Affecting Stadiums Security. Accessed Aug. 23, 2020. https://primo-direct- apac.hosted.exlibrisgroup.com/primo- explore/fulldisplay?docid=TN_cdi_crossref_primary_10_1080_19361610_2018_1498264&context=PC&vid=RMITU&lang=en_US&search_scope=Books_articles_and_mor e&adaptor=primo_central_multiple_fe&tab=default_tab.

Faraji, R. (2018). Critical Factors Affecting Stadiums Security. Journal of Applied Security Research, vol. 13, no. 4, Oct. 2018, pp. 473–88.

Live Science. 20 of the Worst Epidemics and Pandemics in History | Accessed July 31, 2020. https://www.livescience.com/worst-epidemics-and-pandemics-in-history.html

PSAM. Accessed July 31, 2020. https://edition.pagesuite.com/html5/reader/production/default.aspx?pubname=&edid= 3a3b0252-7577-437c-a0c1-af02eca7186f.

Coaffee, J. (2009). Protecting the Urban. Theory, Culture & Society, vol. 26, no. 7–8, 2009, pp.343–55.

Coaffee, J. (2009). Protecting the Urban: The Dangers of Planning for Terrorism. Theory, Culture & Society, vol. 26, no. 8, 2009, pp. 343–55, doi:10.1177/0263276409349656.

RMIT University Library. Protecting the Urban: The Dangers of Planning for Terrorism. Accessed July 19, 2020. https://primo-direct-apac.hosted.exlibrisgroup.com/primo- explore/fulldisplay?docid=TN_cdi_crossref_primary_10_1177_0263276409349656&context=PC&vid=RMITU&lang=en_US&search_scope=Books_articles_and_more&adaptor=primo_central_multiple_fe&tab=default_tab&query=any,contains,designing for terrorism stadia&offset=0

Larcher, M. (2018). Access Control Points: Reducing a Possible Blast Impact by Meandering. Advances in Civil Engineering, vol. 2018, 2018, pp.1–11.

RMIT University Library. Access Control Points: Reducing a Possible Blast Impact by Meandering. Accessed July 19, 2020. https://primo-direct-apac.hosted.exlibrisgroup.com/primo- explore/fulldisplay?docid=TN_cdi_doaj_primary_oai_doaj_org_article_a69daf6950bb4d28737f279fd8e0616&context=PC&vid=RMITU&lang=en_US&search_scope=Booksarticles_and_more&adaptor=primo_central_multiple_fe&tab=default_tab&query=any, contains,stadia terrorism structural engineering&offset=0.

Just Imagine. Can You Have a Sporting Spectacle without Spectators? Accessed July 19, 2020. https://justimagine.aurecongroup.com/sports-spectacle-without-spectators/

Create Digital Magazine. New Stadiums Mean Big Spectacle and Big Expense, so They Need to Be Built to Last. Accessed Feb. 17, 2020. https://www.createdigitalmagazine.org.au/new-stadiums-big- spectacle-big-expense-need-to-be-built-last/

How Big Is Too Big? Designing Economically Sustainable Stadia | LinkedIn. Accessed Dec. 8, 2019. https://www.linkedin.com/pulse/how-big-too-designing-economically-sustainable-stadia-peter-ayres/

Olympic Profile.

ProQuest. Delivering London 2012's Job Legacy. Accessed Nov. 24, 2019. https://search-proquest-com.ezproxy.lib.rmit.edu.au/docview/1611024817/fulltextPDF/AA151867724772PQ/1?accountid=13552

ProQuest – Introduction. Accessed Nov. 24, 2019. https://search-proquest- com.ezproxy.lib.rmit.edu.au/docview/904934011/fulltext/3EF330BC82594916PQ/1?accountid=13552..

Nimmo, A., et al. 2011. Delivering London 2012: Temporary Venues. Proceedings of the Institution of Civil Engineers: Civil Engineering, vol. 164, no. 6, Thomas Telford Services Ltd, 2011, pp. 59–64, doi:10.1680/cien.2011.164.6.59.

ProQuest – Introduction. Accessed Nov. 24, 2019. https://search-proquest- com.ezproxy.lib.rmit.edu.au/docview/905191371?accountid=13552.

ProQuest. Delivering London 2012: The Aquatics Centre. Accessed Nov. 15, 2019. https://search-proquest- com.ezproxy.lib.rmit.edu.au/docview/905191194?accountid=13552.

ProQuest. Delivering London 2012: The Olympic Stadium. Accessed Nov. 15, 2019. https://search-proquest- com.ezproxy.lib.rmit.edu.au/docview/905191374?OpenUrlRefId=info:xri/sid:primo&ac countid=13552

Weber-Newth, F. et al. (2017). London 2012: 'Legacy' as a Trojan Horse. ACME: An International Journal for Critical Geographies, vol. 16, no. 4, Dec. 2017, pp. 713–39, https://www.acme-journal.org/index.php/acme/article/view/1455.

Thornley, A. (2012). The 2012 London Olympics. What Legacy? Journal of Policy Research in Tourism, Leisure and Events, vol. 4, no. 2, July 2012, pp. 206–10, doi:10.1080/19407963.2012.662617.

ProQuest – Pop up Games. Accessed Nov. 15, 2019. https://search-proquest-com.ezproxy.lib.rmit.edu.au/docview/861758951/291FF6D0E18243C4PQ/27?accountid=13552.

Baloyi, L. (2011). Causes of Construction Cost and Time Overruns: The 2010 FIFA World Cup Stadia in South Africa. Acta Structilia. Accessed Oct. 31, 2019. https://www.ajol.info/index.php/actas/article/view/77173/67623.

ProQuest. The 2004 Athens Olympics: A Cost Benefit Analysis. Accessed Oct. 29, 2019. https://search-proquest- com.ezproxy.lib.rmit.edu.au/docview/191693244?accountid=13552&rfr_id=info%3Axri%2Fsid%3Aprimo.

JSTOR. When Icons Crumble—The Troubled Legacy of Olympic Design on JSTOR. Accessed Oct. 29, 2019. https://www- jstor- org.ezproxy.lib.rmit.edu.au/stable/41687780?seq=11#metadata_info_tab_contents.

ProQuest. The Big Read: London Looks to Learn from Others' Mistakes. Accessed Oct. 29, 2019. https://search- proquest- com.ezproxy.lib.rmit.edu.au/docview/507193395?accountid=13552&rfr_id=info%3Axri%2Fsid%3Aprimo.

ProQuest. CIVIL ENGINEERING: Sustainable Games. Accessed Oct. 29, 2019. https://search-proquest- com.ezproxy.lib.rmit.edu.au/docview/751489452?OpenUrlRefId=info:xri/sid:primo&ac countid=13552.

Panagiotopoulou, R. (2013). The Legacies of the Athens 2004 Olympic Games: A Bitter-Sweet Burden. Contemporary Social Science › Journal of the Academy of Social Sciences. doi.org/10.1080/21582041.2013.838297

Appendix A

Appendix A – SurveyMonkey Survey

SurveyMonkey Survey

The aim of the author's survey was to generate as much public opinion as possible to 12 key questions to help narrow his focus and set the scene. The survey was open for approximately four weeks and publicised internally through email, Microsoft Teams and Yammer and externally through email, Facebook and LinkedIn. In total 114 responses were received, which was a positive outcome and provided useful insight to help focus my research.

This appendix expands on the SurveyMonkey summary presented in the main body of the paper with the results presented and brief commentary provided. This survey helped define the focus of the interview questions that subsequently defined the focus of the paper.

Question 1 – My cities main stadium is...

To calibrate the survey somewhat the author initially asked respondents to identify the main stadium that they would consider in response to the subsequent questions. The respondents were predominantly aligned with Adelaide Oval with presumably a large number of personal colleagues, family and friends from the author's home town supporting his research and then decreasing respondents the further out, particularly outside Australia. The respondents identified stadia (sorted alphabetically with number of respondents to each listed) were:

- AAMI Stadium, Melbourne, Australia (2)
- Adelaide Oval, Adelaide, Australia (55)
- ANZ Stadium, Sydney, Australia (5)
- Baypark Stadium, Tauranga, New Zealand (1)
- Cape Town, Green Point Stadium (4)
- Du Arena Yas Island, Abu Dhabi (1)
- Eden Park, Auckland, New Zealand (3)
- FNB Stadium, Johannesburg, South Africa (1)
- Gabba, Brisbane, Australia (4)
- Hampden Park, Glasgow, Scotland (1)
- Hindmarsh Stadium, Adelaide, Australia (2)
- Horncastle Arena, Christchurch, New Zealand (1)
- Kardinia Park, Geelong, Australia (1)
- Loftus Versfeld Stadium, Pretoria, South Africa (2)
- Mall of Asia Arena, Bay City, Philippines.
- McDonald Jones Stadium, Newcastle, Australia (1)
- MCG, Melbourne, Australia (14)
- Moses Mabhida Stadium, Durban, South Africa (1)
- Mt Smart Stadium, Auckland, New Zealand (1)
- Optus Stadium, Perth, Australia (4)
- SCG, Sydney, Australia (1)
- Singapore Sports Hub, Singapore (2)
- Sky Stadium, Wellington (1)
- **Suncorp S**tadium, Brisbane, Australia (3)
- Thong Nhat Stadium, Ho Chi Minh City, Vietnam (**1**)
- Wanderers Cricket Stadium, Johannesburg (1)

Question 2 – What is your interest in stadia? Tick all that apply

Given the SurveyMonkey was directed through open social media platforms anonymously my second question sought to identify the relationship respondents had with stadia from operator, designer to fan and how often they attend and under how many categories.
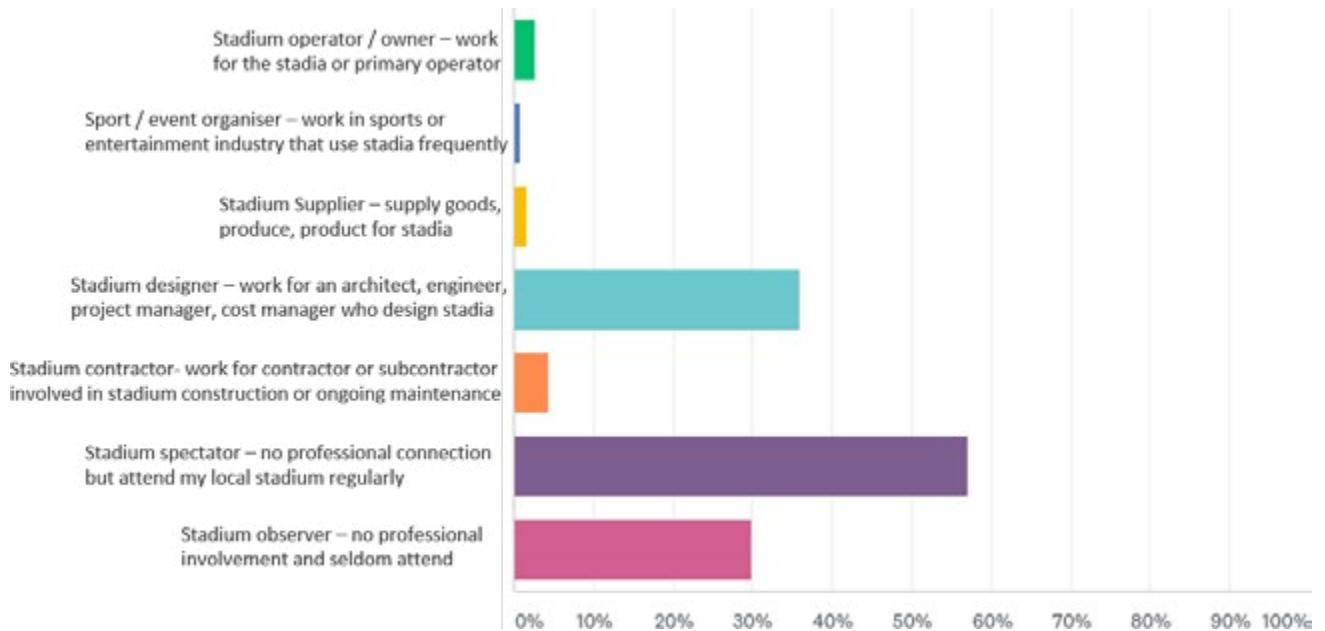

Figure 24 – What is your interest in stadia? Graphical summary

This question identified that most respondents were genuinely connected with their local stadium with 57% attending regularly. The author was also pleased to find 36% of respondents were involved in stadia design giving a greater confidence that the respondents understood the general design nuances.

Question 3 – How often do you attend your city's main/primary stadium?

This question identified the frequency respondents attended their stadium, further elaborating on the previous question. The free text responses indicated that attendance was often seasonal with greater frequency for the preferred summer or winter season; however, with approximately 70% of respondents attending less than six times per year it appeared an opportunity to improve stadia success if this could be raised.
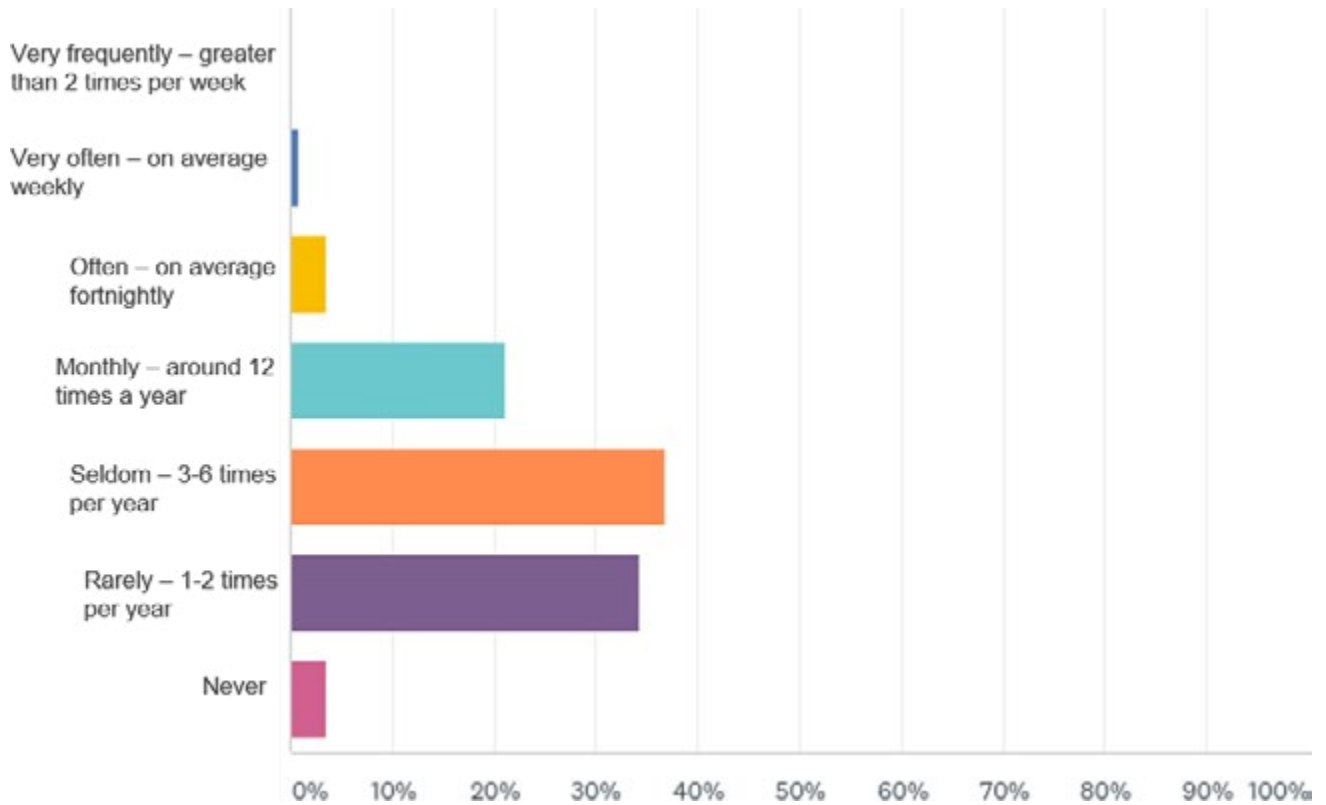
Figure 25 – How often do you attend your city's main/primary stadium? Graphical summary

Question 4 – Rank the importance from 1 very important to 5 not important for each of the stadia location issues that follows:

Question 4 set the challenge to respondents on one of the key design parameters in stadium location. The results reflected what has been reported throughout the author's literature research with stadium location more than ever focused on easy connection to public transport, and as close to the city centre and entertainment precincts as possible. The stadium design intent of the 1970's and much of America for suburban grounds with extensive carparking appear to have run its course.
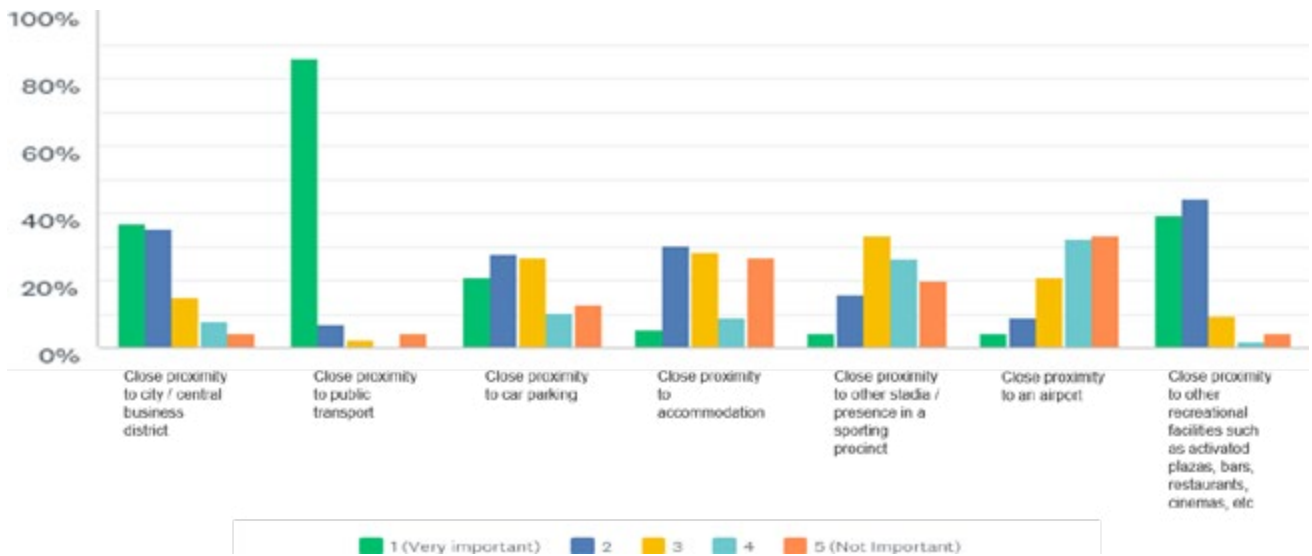
Figure 26 – Rank the importance for stadia location issues. Graphical summary

Question 5 – What are the three most important factors in a stadium for you to view it as successful?

Opening the design factors and seeking a ranking identified a greater focus on the key factors of the respondent subset. Stadium location was very clearly identified as the key factor suggesting that without the right site the stadium success is always under duress as evidenced in the author's experience with the AAMI Stadium Redevelopment. This promised a high quality A$200M redevelopment of the existing West Lakes site approximately 16km west of the Adelaide city centre, ultimately usurped in spectacular fashion by the

$550M Adelaide Oval Redevelopment within 1km of the central business district. After location, a clear band for spectacular experience was evident in atmosphere, views, amenity and weather protection strongly supported.
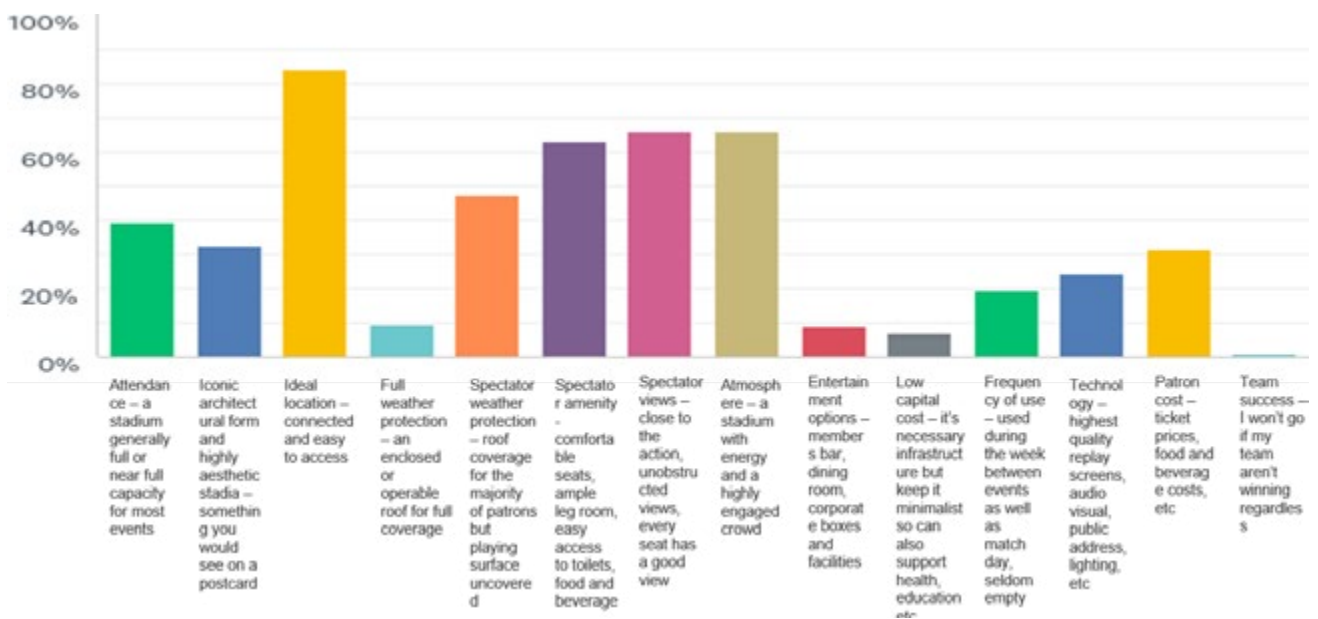
Figure 27 – What are the three most important factors in a stadium for you to view it as successful? Graphical summary

Question 6 – Do you view stadia when on holidays away from your home city abroad? Tick all that apply

Question 6 sought to understand the respondent interest in stadia as a typology set by how they would interact while on holidays, which indicated a general interest perhaps reflecting the passion for sport of many Australians who likely dominated the respondent list.
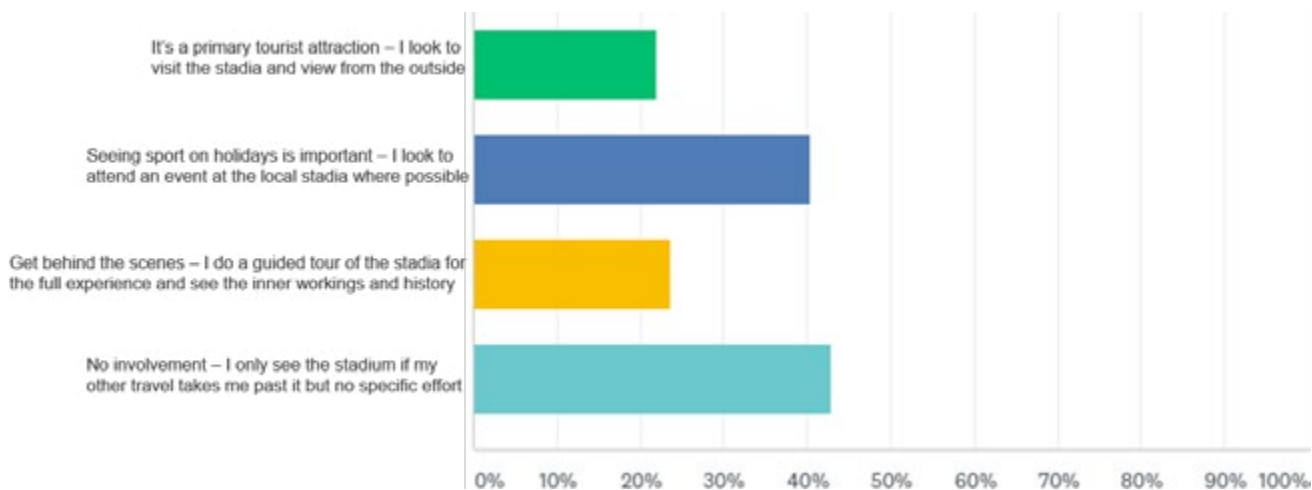

Figure 28 – Do you view stadia when on holidays away from your home city abroad? Graphical summary

Question 7 – Consider the most recent redevelopment to your city's main/primary stadium – tick all that apply

Stadia represent major investments with most stadia at least in the hundreds of millions of dollars, if not billions. Stadia investment can be a controversial issue and this question sought to understand the views. Given most respondents were aligned with Adelaide Oval and the MCG both of which are generally regarded as highly successful stadia with new redevelopments in the past decade, the results perhaps unsurprisingly supported these investments.
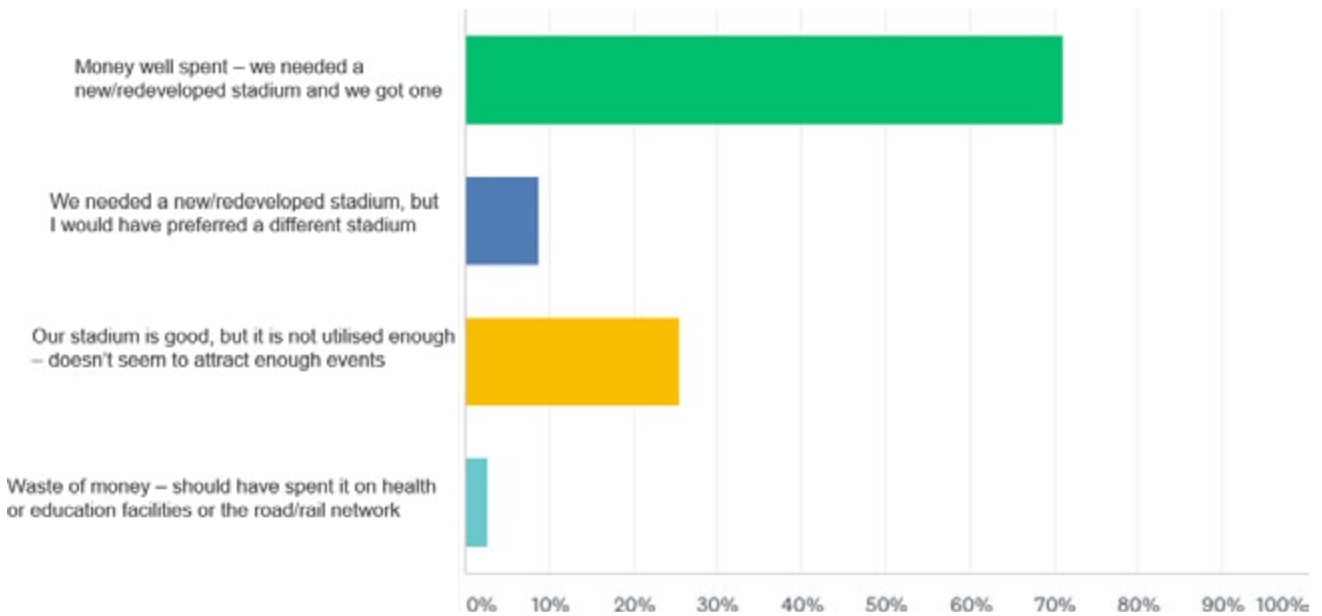
Figure 29 – Consider the most recent redevelopment to your cities main / primary stadium. Graphical summary
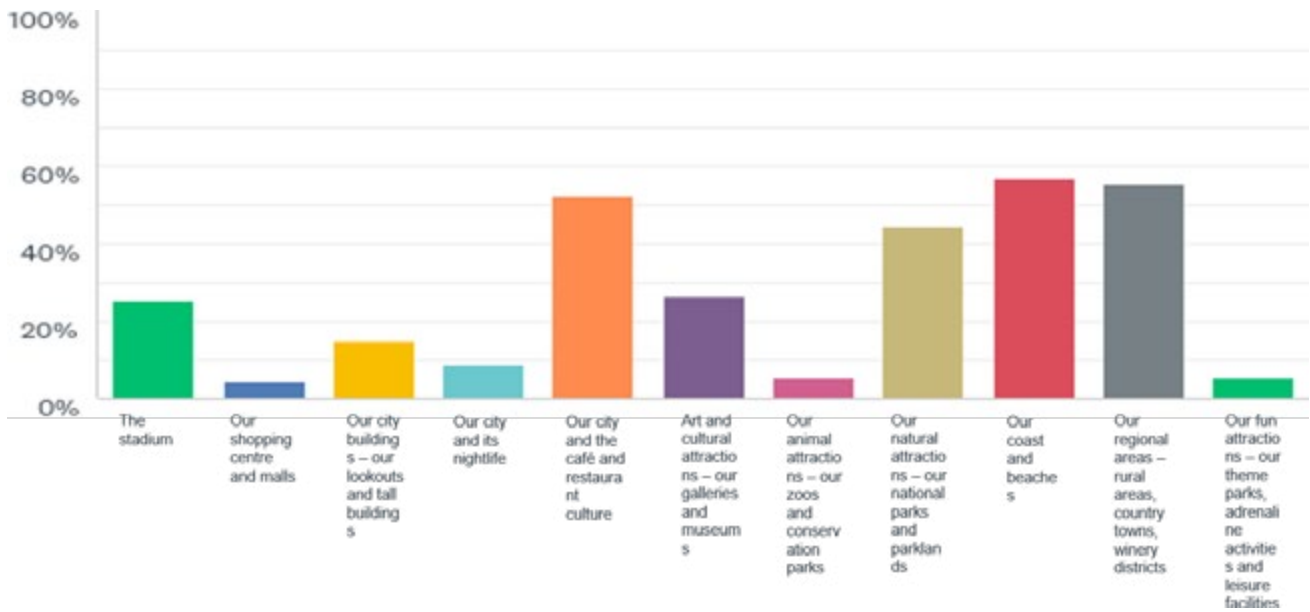
Question 8 – What do you consider as the greatest source of pride for your local district/city and what you visit most with visiting guests and tourists? Select three

This question built on question 6 testing the importance of the local stadia in the psyche of the respondent, this time while hosting guests. Conversely to the question 6 response, the stadia was not a prevalent preference over other attractions perhaps reflecting the difference in knowledge of a city more broadly as a resident compared to the city knowledge as a visitor.

Figure 30 – What do you consider as the greatest source of pride for your local district/city and what you visit most with visiting guests and tourists? Graphical summary

Question 9 – How do you see a stadium should run commercially?

Similarly building on question 7 was the question of how the large capital investment should be funded. Approximately 80% believed government funding of the capital cost, then operator the maintenance and operational costs was their preferred financial model.
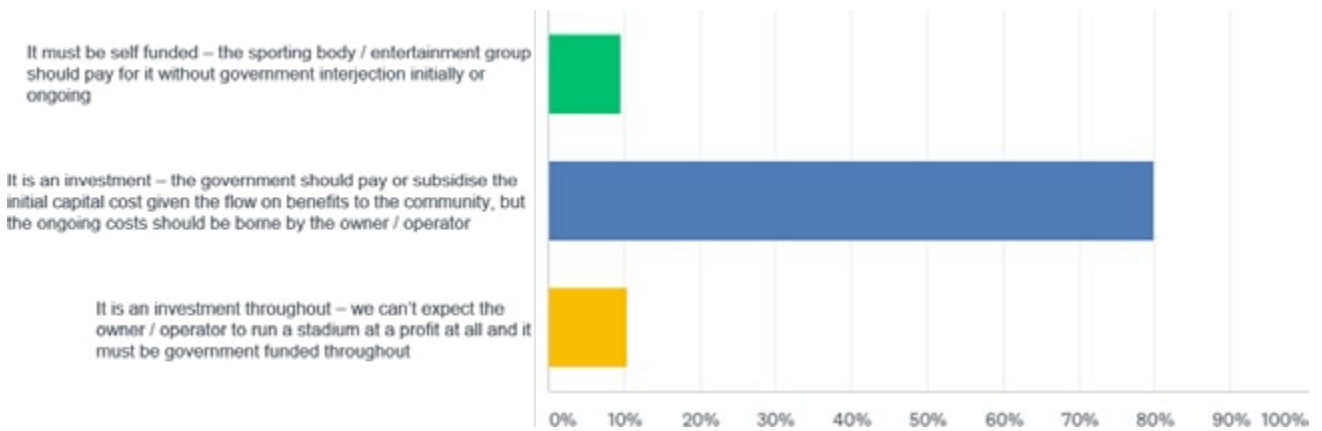

Figure 31 – How do you see a stadium should run commercially? Graphical summary

Question 10 – How big should an ideal stadium be?

Perhaps the most open ended and controversial question in the survey based on the free text feedback given the extreme range the question demanded while ignoring the key factors. In general terms, there was a preference for large to arena size stadiums. Emerging trends worldwide tend to indicate the stadia greater than 60 000 capacity are proving harder to justify and harder to fill and create the atmosphere the live experience demands in all but the premium events. The value of creating a premium and a demand appears present.
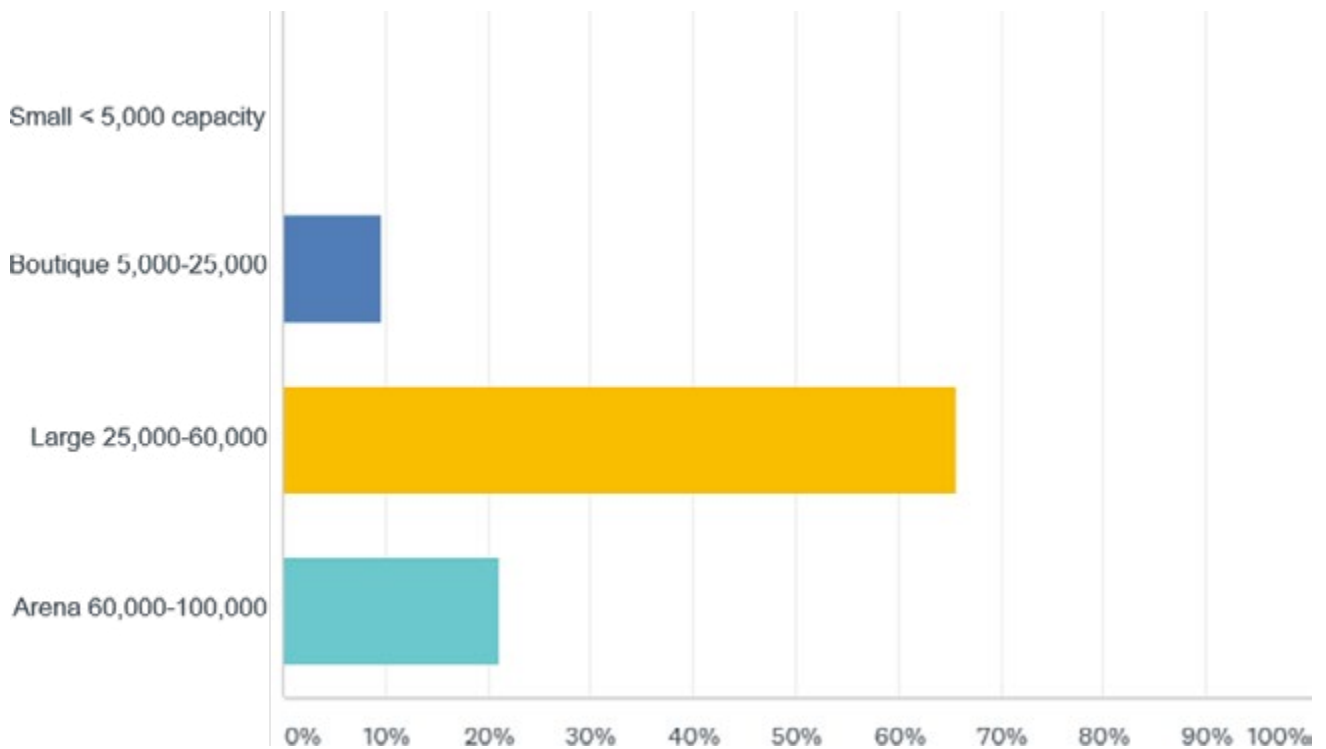

Figure 32 – How big should an ideal stadium be? Graphical summary

Question 11 – Stadia are becoming linked with adjacent uses. What other development would you see as complementary to your local stadium? Tick all that apply

Emerging trends indicate that stadia form part of a precinct and part of a community rather than being isolated. Stadia around the world tend to operate within overall sporting complexes (consider the MCG as an example), within parklands and natural spaces (Adelaide Oval, Optus Stadium, Perth) or business and commercial precincts (Marvel Stadium, Melbourne). The survey indicates that whatever the precinct, public transport and ease of access remain paramount.
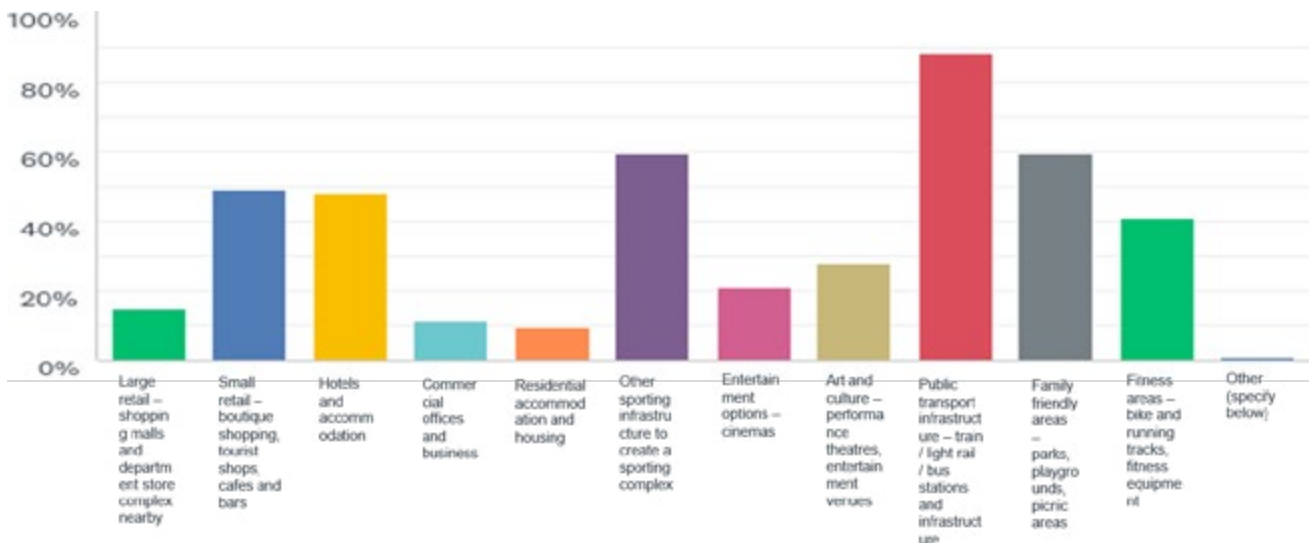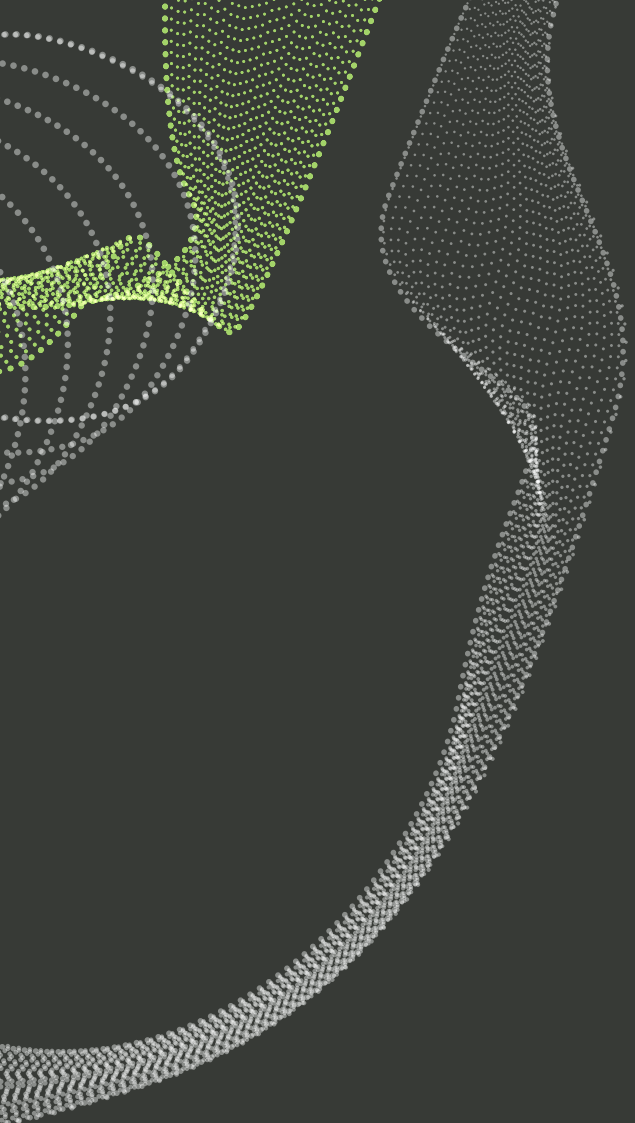

Figure 33 – Stadia are becoming linked with adjacent uses. What other development would you see a complementary to your local stadium? Graphical summary

Question 12 – Do you have any other thoughts or suggestions on emerging trends, what you love in stadia, what you would like to see in the future, and what innovative ideas would you like to see?

The author's final question invited free text response to see trends that respondents might identify. The responses were many and varied but fell into a few key categories:

- Technology – digital connectivity, data and statistics, connection with a mobile phone

- Food and beverage options – a desire for improved variety and quality of food, including a push away from fast food to healthier options

- Affordability – the costs of the stadium experience from ticketing to food and beverage and merchandise

- Ease of access – presence for public transport, improved facilities for cyclists, taxi and ride share facilities, autonomous vehicles a future provision envisaged

- Variety of seat offerings – sit/stand seating, different tiers of general admission, members and corporate offerings

- Atmosphere – the importance of an active and vocal crowd to the experience, which has been emphasised this year with sporting events being held without crowds due to COVID-19

- Flexibility and adaptability – the ability of the stadia to operate between events, a more active facility

- Safe and secure – to be able to attend in comfort – easy and care-free

- Full experience – from arrival and pre-event to the event itself and then post-event and departure – the desire for the stadia experience to be broader than just the event

- Activated precinct – stadia within a precinct to facilitate activity before and after an event and on non- event days, connected to other activities and experiences

- Sustainable – stadia need to be environmentally responsible

- Design – iconic and memorable, connected to the city and community, architecturally expressive

The trends identified in the SurveyMonkey made for interesting reading and generally appeared to envelope the research the author had undertaken. Finding the solution to these challenges remains the challenge.

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Bringing ideas to life