SCOTT BROWNRIGG
DESIGN RESEARCH UNIT

INTELLIGENT ARCHITECTURE \ ISSUE SIX

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Introduction: Architecture and movement

The very notion that architecture is inclusive of movement is, of course, obvious. We have, however, within our thematic proposal in this addition of iA, expanded the definition of what architecture and movement actually includes. This new definition is not, however, wilfully liberal; it tries to challenge what might be conceived to be the orthodoxy, but at the same time is grounded in the real engagement in an architecture that embodies movement as its essence.

Infrastructure, if all is to be believed, is on the rise in the UK in our post-Brexit world. It is where public and private expenditure will be concentrated to fill the gap (if there was one) of EU funding for capital projects within regional and national contexts. It is (or can be) a facilitator of economic growth and social progress. Our focus on the regional scale is therefore both apt and relevant.

So we look at current themes and trends within infrastructure through our national and international projects and where current thinking might take us (excuse the pun or metaphor for movement!), but not just within the blinkered view of transportation – but rather how transportation schemes may been seen as critical to place-making – not just simply to the idea of moving large numbers of people around from one location to another.

We also evaluate this current thinking against a historical context – where we have come from (again, apologies for the pun) and how these major projects were the cause and substance of paradigm shifts in the industrial revolution, innovation and the driving force behind our contemporary cities – where they are located and how they informed the very fabric in which we still live.

ABOVE
MSCP Cardiff Bay

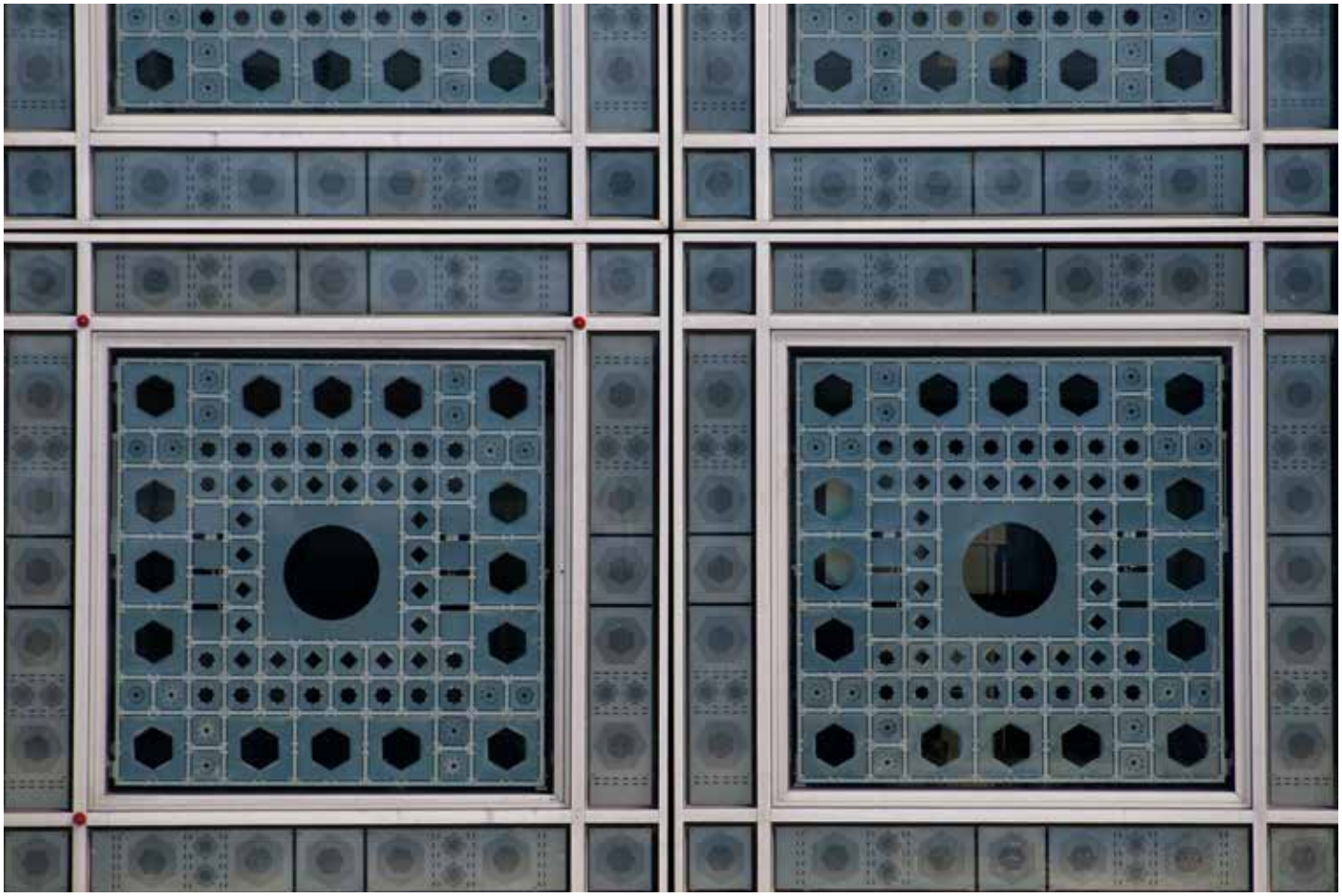
We also review research into projects that have notions of movement embedded within their concept, but in a less obvious way. Ideas about "kinetic" architecture – buildings that actually move – have been a pre-occupation since the industrial revolution and "Architecture of the First Machine Age" [1]. Ron Herron's walking cities are an extreme example, but architecture that has façades or components that move or respond to particular environmental or contextual conditions (Jean Nouvel's Islamic Institute in Paris for example) are concrete examples of how the tradition of architecture and movement have manifested themselves over the years.

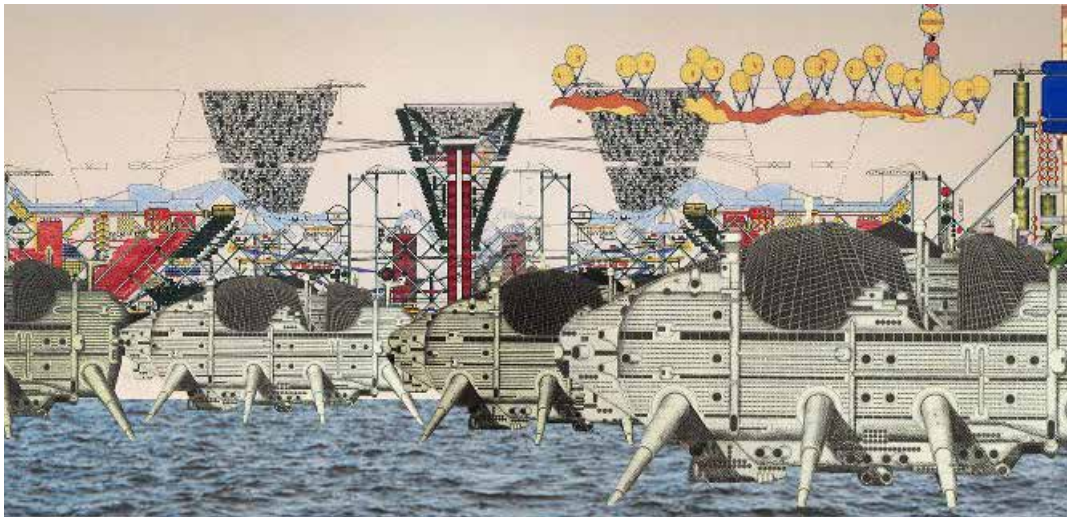
Our own studies also look at such themes in perhaps more elusive and abstract way – a façade seen from a moving car that alludes to movement (Cardiff Bay Car Park) and the way in which one component is seen in juxtaposition to another (ideas of parallax), to architecture that embodies and contains the speed of light.

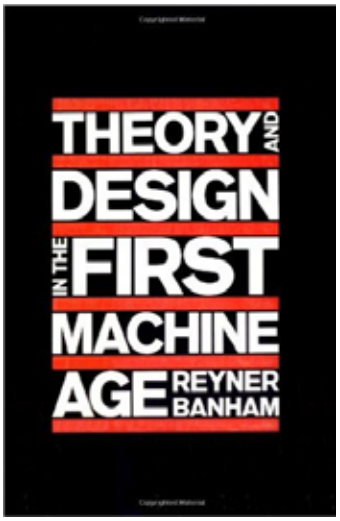
The idea of architecture and movement equally operates from the micro as well as the macro; from a chair to an airport.

Then there is the synthesis of the pragmatic and the poetic – how the very movement around buildings can trigger the kinaesthetic experience that is memorable and pleasurable; how moving from one space to another can encompass and embrace theories of syntax, threshold and transition from one world to another - the existential ●

[1] **Banham, Reyner. 1960.** *Theory and design in the first machine age.* **MIT Press.**







CLOCKWISE FROM ABOVE

L'Institut du Monde Arabe by Jean Nouvel architect, Paris

Theory and design in the first machine age. [Book]

Walking City by Ron Herron, Archigram [Image]

Retrospective: The Victoria line

When the Victoria line opened in 1968 it was considered to be the most advanced underground railway in the world, with the introduction of computer controlled trains and automated ticket barriers improving energy, time and cost efficiencies all around. It made services more regular and uniform and reduced staff costs – trains could be driven by one operator instead of two. Running from Brixton to Walthamstow Central taking in prominent stops Oxford Circus, Euston and Kings Cross St. Pancras, the Design Research Unit's light blue line is steeped in history. Here at Scott Brownrigg, Head of Marketing and Communications Claire Donald looks back at it.

The Victoria line was the first completely new deep level underground line to be built across central London for over 50 years and is the longest entirely underground line. Originally taking in just 16 stations it was also one of the shortest on the London Underground.

The name "Victoria line" dates back to 1955; other suggestions were "Walvic line" (Walthamstow–Victoria) and "Viking line" (Victoria–King's Cross before the better known Victoria line was decided upon.

Funding for the deep-level "Route C" line was approved in 1955, yet post-war austerity meant that new stations were often less impressive and showed little design innovation - often being 'watered down' by the impact of austerity. Many young architects left designing railways during this period, disappointed that their vision of a post-war utopia was being eroded by economic and bureaucratic obstructions. It wasn't until the Victoria line was built that a new design philosophy emerged. Developed by the Design Research Unit, a collective of designers, artists and architects, the latest line provided the opportunity to produce a new and consistent look, from the trains themselves to the stations and platforms. All aspects of the design were overseen by Misha Black, the Design Consultant for London Transport (1964–1968) and the London Transport Design Panel which consisted of Chief Architect Kenneth J.H Seymour, Harold Hutchison and others. Black had previously held a similar role with British Rail and would subsequently through Design Research Unit, go on to act as London Transport Consultant until the 1980's.

Whilst cost-cutting meant that the outcome for the line was less ambitious than was originally hoped for, the project was the first post-war example of a London Transport design programme that saw a return to the integrated Frank Pick model. Pick, the Chief Executive of London Transport, had been responsible for the company's corporate image until 1940. However in the intervening two decades there had been no cohesive design vision directing London Transports operations. Working very much in the vein of Pick, Black was concerned with 'fitness for purpose' commenting:

> "We should approach each new problem from the base of practicality - how it can most economically be made; how it will function most effectively, how can maintenance be simplified and how can use of scarce resources be minimised."

Coordinating every aspect of its design, all stations, trains, internal fittings and posters had a unity of approach that had not been seen since Pick.[1]

Completed in stages between 1968 and 1971, apart from Blackhorse Road station, works were mostly underground with limited architectural possibilities. As the line connected mostly existing stations, the focus for design was on the platform areas. Each platform featured a uniform scheme of light grey tiling to provide a neutral background for posters and signage. The very muted colour scheme was described by some of the press at the time as the 'late lavatorial style', clinical and drab, however the designers Seymour and Black in 1969 commented:

> "The stations may be criticized for appearing visually unexciting, but we consider that preferable to a transient popularity without lasting qualities."

Mosaic tesserae and brushed stainless steel detailing added a richness and variety. Each station was decorated with unique tiled motifs in seating recesses, helping to visually identify each station to train passengers. The unique designs were created by artists such as Edward Bawden and Hans Unger. These designs provided much needed colour and decoration, and gave each stop its own visual identity. The results were a mixture of direct inspiration from the station name and references to historical details of the local area. Walthamstow has a Morris & Co-style leaf pattern (by Julia Black), while at the opposite end, Brixton has a ton of bricks in a red octahedron by Hans Unger. Also by Unger are the designs for Green Park (5 x 3 dots in yellow, green and blue to represent a bird's eye view of the park), Oxford Circus has a circle and dot motif in the colours of its three intersecting lines, Seven Sisters has the eponymous seven trees and Blackhorse Road has a paper cut-out of a horse against a background of Pantone 299, the blue of the Victoria line. The neoclassical arch at Euston, which

was lost to the building of the new station, was memorialised in Tom Eckersley's design. Whilst Vauxhall's alludes to its pleasure gardens and Victoria to its namesake - a cameo profile of the queen. Edward Bawden, who designed Victoria, also created the woodcut at Tottenham Hale of a medieval passenger being ferried across the River Lea, complete with eggs, chicken and dog, and the image at Highbury and Islington is of a bury or 'fort' on a hill (the original high bury was destroyed during the Peasant's Revolt). Abram Games's swan at Stockwell references the Swan pub / club which still stands above. As in his 1956 poster for Guinness, Games adds a little flourish to transform the image: a small orange triangle and a small black one make a swan appear in the zig-zag of white and blue.

In addition to the mosaics, panels in tickets halls provided accents of orange or yellow to help identify obstructions such as columns.

Every Victoria line station was deliberately designed to interconnect with existing lines, the line therefore has an unusually large proportion of interchanges. Interchanges with other tube lines facilitate a wide variety of north/south journeys across central London. Every station but one is either served by National Rail or another Underground line. Cross-platform interchange was also viewed as important and several existing stations were rearranged to allow for this with the new line. In two cases - Oxford Circus and Stockwell - the tracks were taken around the outside of the existing platforms, which were then shared. In others, the Victoria line uses one of the older platforms and the existing line was diverted into a new platform. At Euston and Highbury & Islington the work was more complex: the existing island platform became the interchange platform for one direction of travel, while a new island was created for the other direction and one track of each line diverted into it. At Finsbury Park, there were two separate island platforms for the Piccadilly line and the Northern line; these were reconstructed as Northbound and Southbound platforms and the Northern line was cut back to Drayton Park in consequence.

Each platform constructed specifically for the Victoria line from new was 132.6 metres (435 ft) long. The line has hump-backed stations to allow trains to store gravitational potential energy as they slow down and release it when they leave a station, providing an energy saving of 5% and making the trains run 9% faster to a speed of 87.2 km/h. The line was constructed with increased tunnel diameters to reduce air resistance, with the tube varying between 3.71m (12'2") and 3.86m (12'8") in diameter, depending on the type of lining (concrete, bolted iron, flexible iron). →

CLOCKWISE FROM BELOW

Blackhorse Road underground horse mosaic

Highbury and Islington underground fort mosaic

Stockwell underground Swan mosaic

Walthamstow Central underground Morris & Co-style leaf pattern mosaic

TRAIN DESIGN

The design for the trains was a collaboration between Misha Black and the Underground Drawing office at Acton Works. Two features were considered major achievements - the stylish design of the front end of the trains and the technical accomplishments of automatic train control (ATO). In fact Black's influence over the front end shape amongst many of the 1967 stock features is often considered one of his best contributions to Underground train design. Although the Victoria line was conceived in a climate of reduced government funding which affected its aesthetics, its designers should still be applauded for the clean, space-age lines of the original bare-metal-finished trains and the ingenuity of the ATO.

The 1967 designed Tube Stock trains were normally 8 cars (two 4-car units) but 4-car trains could run in service if they were "double-ended" (some units only had ATO equipment in one of the cabs and were thus "single-ended"). The stock could run empty on certain other lines if tripcocks were fitted, and were then limited to a maximum of 30 mph.

Carriages were designed with 36 seats as opposed to 40 and arranged longitudinally to create more space for passengers. The unpainted silver finish and wrap-around windscreens of the trains gave London's new tube a fashionable space age look.

The stock was worked hard up and down the 20 kilometres of the Victoria Line for over 40 years and provided the main bulk of the service until withdrawals started in March 2010. The last car was removed in July 2011 by Metronet as part of their maintenance and replacement programme for the line. Apart from the 4 car units used between Woodford and Hainault, on the Central line, the Victoria line was the only line the stock worked on. During most of these 40 years it was carrying more people than it was designed for – it is therefore considered a tribute to its original designers and manufacturers that it lasted as long as it did.

On 7 March 1969, the official opening ceremony took place at Victoria station where Queen Elizabeth II unveiled a commemorative plaque on the station concourse. After a short ceremony, she bought a 5d ticket and travelled to Green Park. She was the first monarch to ride on the tube.

Nowadays the Victoria line is used by 200 million passengers each year. In 2012 a major upgrade to the line completed which saw the introduction of state-of-the-art signalling and a brand new fleet of trains. The Victoria line is now operating the most frequent service in the UK with up to 34 trains per hour during peak times ●

[1] **Exploring 20th Century London website.**

BELOW

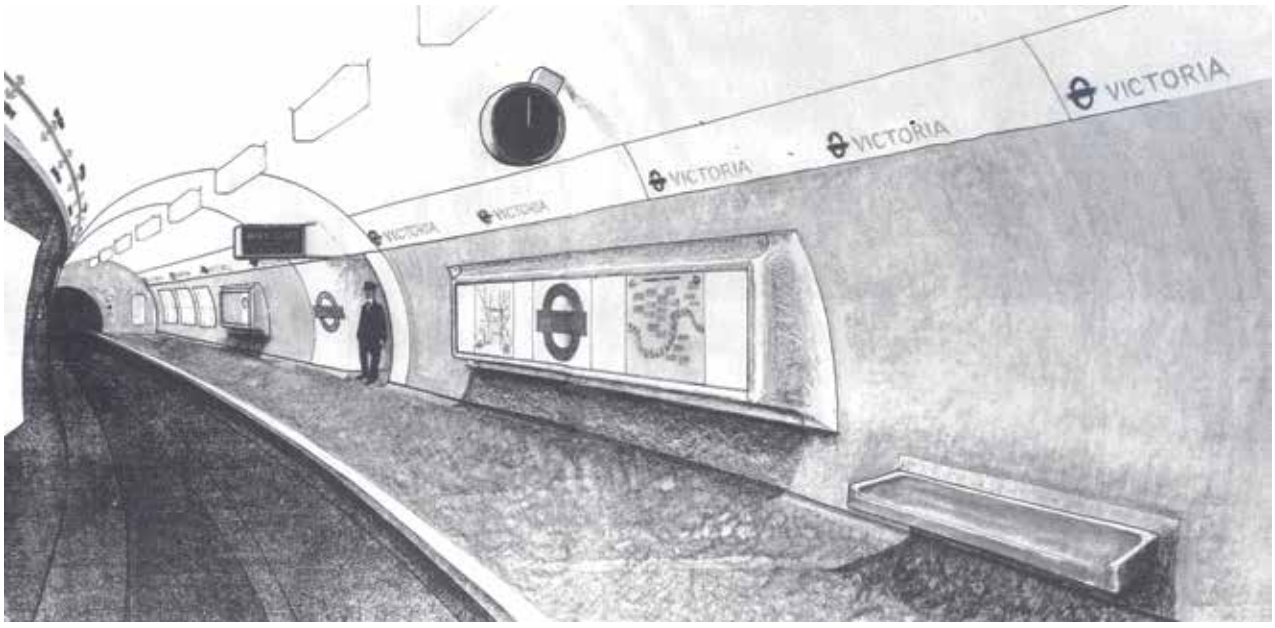
Euston underground

CLOCKWISE FROM RIGHT

Inside the tube

Oxford Circus underground

Victoria underground sketch



Pure Research 1:
Cultural influence on airport design

The inexorable rise of air travel and the shrinking of our world in terms of accessibility have meant the demand for airports has risen sharply in the last fifty years. Here Project Director Alistair Brierley explores the ever changing experince of airline passengers and the importance of cultural influences on airport design.

At any one moment 800,000 people are flying in aircrafts. How many is this per day, per month or year? Gone is the romantic world of flight with the glamour and mystery that surrounded it. From the Wright brothers through to Amy Johnston, BOAC and BEA the world has moved on, and these individuals and proud airlines are now distant memories.

During the early twentieth century Fritz Lang in his film 'Metropolis', Marinetti in the Futurist manifesto, St Elia the young Italian visionary with his drawings, and eventually Saarinen at TWA in New York captured the purity, exhilaration and excitement of speed and flight in their work. Nowadays the notion of flight and architectural metaphors or signifiers are largely abandoned by architects. Saarinen's poetic TWA terminal, with its swooping curves is virtually a museum piece and in terms of the pressures of its New York context cannot cope with the 21st century version of air travel. The building is now redundant as a terminal.

Although contemporary airports are growing rapidly in scale and ambition (and are fast becoming 'nation- states' in their own right), remnants of the past still survive and a handful of airfields from the early and mid-twentieth still operate. They are to an extent recognised as anachronistic and an inefficient indulgence. Giovanni Nicelli, set on the Lido in Venice is a striking building from 1935, complete with a grand piano in the lobby and Futurist murals providing the décor along with the possibilities of arriving by bike or boat. Courcheval in the French Alps is little more than a wooden hut constructed in 1961, and Barra Airport in Scotland is dependent on the tides as the adjacent beach provides the runway'. The atmosphere generated in these small and unique locations allows us to experience flying and the natural world more closely. The passenger always approaches the aircraft on foot across the apron. This opportunity is now rare and unless an airport is oversubscribed and has inadequate gate provision the chance to walk alongside the giant fuselage and board via step access has gone.

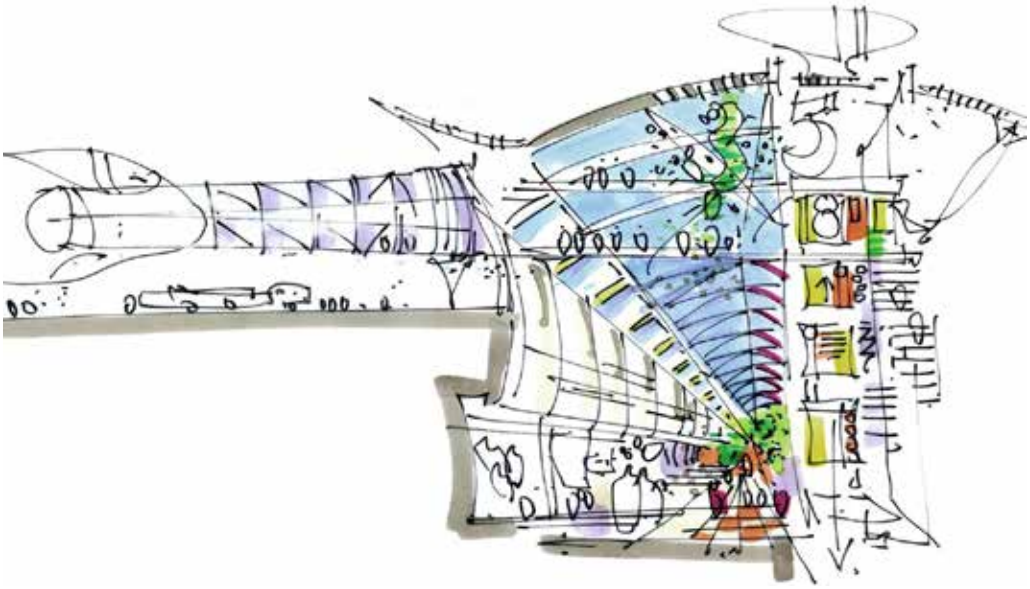
Indeed aircraft are becoming less visible to the passenger. It is now possible to arrive on an underground train link, progress from 'landside' to 'airside' and board an aircraft whilst barely seeing the airfield and the sky. This says little for the enhancement of the passenger experience. Airports are now focused on their retail offer and the 'mall' has become a ubiquitous element of contemporary facilities.

At Istanbul Grand Airport where Scott Brownrigg is engaged as Lead Designer for this mega hub (eventually to process 150 million passengers a year) there is over one million square feet of retail planned for the building as well as a large hotel. This enormous facility on the Black Sea coast is a game changing move from Turkey in terms of global aviation.

The economic growth and facilities that will arrive with its development aim to deliver what amounts to an instant 'pop-up' city. A place with no history or context, liberated from the past. Some find this concept depressing and claim that these places are without soul, cultural texture or depth. There is nothing that resonates or fires the imagination of the passenger.

Others such as JG Ballard, the visionary writer find these places energising. He lived for many years on the fringes of Heathrow airport and delighted in the 'alienation, transience and discontinuities that responded to the pressures of speed, disposability and instant impulse. 'He identified airports as a new kind of 'discontinuous' city where the individual is 'no longer bound by civic obligations.

The crowds that flow forever are always just passers-by; they are never neighbours or property owners or people with a claim to anonymity or privacy. They are by definition random and unpredictable. Specific types or events or attitudes or experiences cannot be anticipated. An easy camaraderie rules the departure lounges along with the virtual abolition of nationality.' →



TOP IMAGES
Retail concept at IGA

CENTER IMAGE
Istanbul Grand Airport

RIGHT
Sketch section of underground pier

This debate raises the issue of airports and their cultural identity. Why bother to impose expressive architectural metaphor to an international airport proposal? These buildings are after all gateways into individual nations and a sense of pride may demand that such significant 'portals' advertise and declare their cultural hand. Well-handled these narratives can work and integrate with the architecture to create a great building, but the question still remains - are these narratives forced and derivative?

At Istanbul, Scott Brownrigg has used a contemporary version of the Ottoman vault to recognise an inherent quality of Constantinople, whilst in Medina the palm became the key motif for the architectural and structural expression. Sixty tonne prefabricated tree structures spanning 36 metres were craned onto site to support the intricate roof above the 'processor', whilst solar shading based on palm fronds ameliorate the effects of low east and west sun. Tented structures reference the Bedouin history of the region, and a large mosque forms part of the landside infrastructure. Add to this the fact that Medina was built and designed as a facility for Hajj pilgrims, (inexperienced flyers who surge through the facilities at specific times of year) and it can be seen that the cultural references for airport design don't just acknowledge local history in their architectural expression, but also in their planning.

Conversely Ballard had no time for the past and looked forward. He recognised that for the operator the airport terminal is a means to an end. Its purpose is to process passengers, and as many as possible. This is an efficient and ruthless money making machine, dictating that the plan of both the terminal, and the capacity offered by the configuration and flexibility of the departure gates are paramount and central to long term success. The success of stylistic gestures is harder to evaluate.

An apparent contradiction to the speed and efficiency of 'processing' now lies in the retail and leisure components that are increasingly apparent in large airports. Here we are creating a world of temporary 'stage-sets' within their more fixed shell and core construction. In terms of 'fit-out' almost anything goes as long as it is branded and themed. Larger airports are now offering hotel and office facilities within their terminals as well as luxurious gardens, a host of restaurants and increasingly exotic retail offers. This means that the airport can now hold and contain visitors for days rather than hours. 'Super-hubs' like Istanbul will aim to retain passengers for longer periods of time where they can use the ready-made vacation facilities on offer and add to their profitability.

In submitting a competition entry for Long Thanh in Vietnam, Scott Brownrigg has referenced Vietnamese culture in their entry and developed the design around the specific character and personality of this country. The form of the building references and respects the vernacular traditions that have informed Vietnamese architecture through the centuries. Climate has been a fundamental consideration for the Vietnamese builder. Form and function combined with the availability of specific local materials has led to a great tradition of roof construction offering shade and shelter, as well as a response to the heavy rainfall of the monsoon season.

The competition entry has learnt from these traditions whilst interpreting them in a modern and contemporary manner. The undulations of the roofs whilst controlling rainwater run-off in the wet season, reference the sinuous terraces of the indigenous landscape, the undulations of fluttering silk ribbons and the curvatures of a dragons' back.

All in all the architectural form of the competition entry synthesises and distils the unique sense of place embodied in contemporary Vietnam and expresses it in a strong but abstract statement that embodies the culture of this unique country.

As our world moves faster and it is increasingly hard to hold on to a sense of individualism and identity there is a growing need amongst people for a cultural thread or narrative to inform and richen their lives. Airports and their architecture offer a chance to engage with the notions of place, nationality and history whilst still operating as high- tech factories for the safe processing of passengers in an increasingly unstable global environment ●

CLOCKWISE FROM LEFT

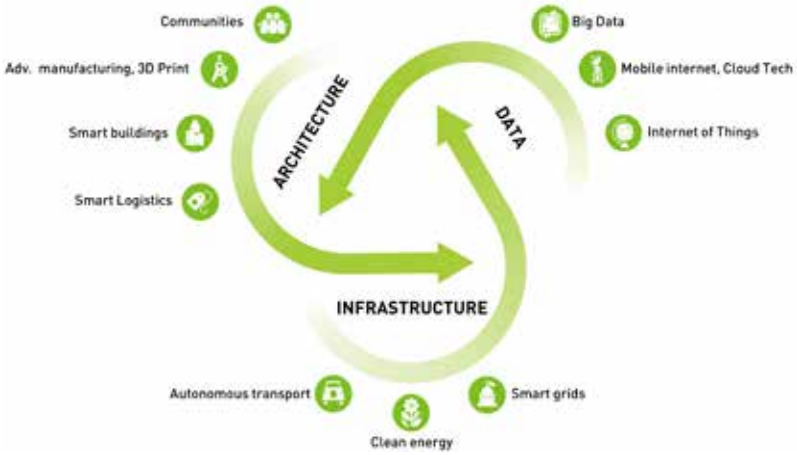
Concept for Airport Terrace / External walkway

Palm structure at Medina Airport

Concept design, Long Thanh Airport, Vietnam

BELOW

Concept design, Long Thanh Airport, Vietnam



Pure Research 2: Data centres - speed of light towards digital real estate

Not all architecture is static, on the contrary, there is a global real estate positioned at the interface between the digital and physical world which is ubiquitous and kinetic. It is emerging from an intercontinental cloud' of mission critical facilities comprising trans-ocean landing stations, repeater nodes, hyperscale and proximity data centres joined together by a global network of unseen fibre optic cables enabling data to travel at the speed of light connecting organisations and individuals across the planet. Increasingly these mission critical facilities are no longer discreetly located within the stealth architecture of stand-alone facilities, they are ubiquitous: whether embedded within an airport, office, factory or research laboratory physically connected to the users which rely on them and complexes which power them. Here Iain McDonald, Director of Advanced Technologies explores this further.

Increasingly meta projects under the umbrella term 'Smart City' or new build and adaptive projects which we term 'Smart Block' reflect the convergence of data and energy within emerging architectural typologies which will be the embodiment of what can be termed Digital Real Estate (DRE).

SMART CITIES

Antoine Picon has observed that 'rather than conceiving of a city whose circuits of information and communications are simply sprawled out and whose intelligence contributes to reside exclusively within the men and women who communicate through them, why not imagine the progressive development of non-human forms of reasoning and even of consciousness'. What Picon is describing is the entire city being considered intelligent in a new way, 'founded on the interaction and composition of the perceptions and deliberations of multiple entities: human, non-human and often a mixture of the two.'

At Scott Brownrigg we are analysing and manipulating data, particularly how non-cultural entities will shape our experience of the city and the pervasiveness of 'sentience' as sensors become ubiquitous in urban environments also what Ray Kutzweil describes as the 'singularity' ie the processing capacities of machine perception and reasoning. This is informing our urban planning strategies at a meta level ie digital real estate and the sentient and sensual city invested with 'new and unexpected functionalities and meanings.' Is modernism re-emerging as big data? where in machine learning and artificial intelligence join than human aesthetic, taste and spatial requirements as determining factors.

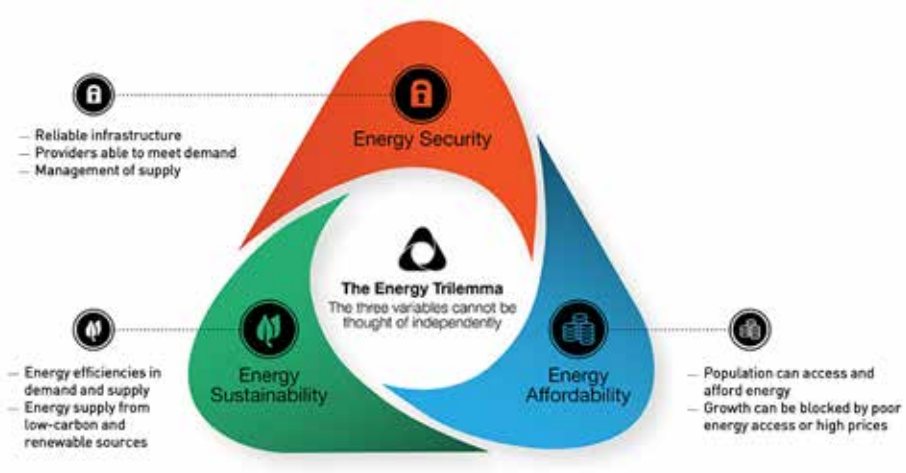
Florida and Glaeser consider the sensitised city to be based on the knowledge economy. The notion that the smart city is both sentient and sensual based on the identification of millions of elementary occurences from individual consumption to atmospheric quality. Using real time data the smart (kinetic) city is able to master situations and scenarios – but is it top down or bottom up? ie a neo-cybernetics inspired or collaborative city. Already more than 50 billion connected devices are sending data online but if hyperconnectivity is a marker of urban disparity and integration, smart cities may be no better than the urban networks of the industrial era unless there is more than

LEFT

Digital Real Estate – Source: FMAC

RIGHT

Intelligent Energy – Source: Arup



one model. Critics posit that 'the commoditisation of digital real estate is a physical manifestation of the monetisation of the citizen'. By contrast Picon advocates there is no collective intelligence without shared values and that smart cities are destined to become the melting pot of a new collective morality.' We would contend that 'smartness is not just about creativity and that the era of the industrial city is not over rather it is transforming, re-tooling, with the disruptive potential of Industry 4.0, countering the cultural and economic 'tunnel' effect.

Paradigmatic shifts are taking place in scientific processes (E-Sciences) and industrial policies (E-Infrastructure) which are having a strong impact on how our cities are developing. In fact, although abstract values such as computational capacity and communication technologies are swiftly imposing themselves as decisive parameters, space has by no means become an obsolete category. On the contrary, these processes are deeply rooted in the dynamic strategies shaping the built environment on the one hand and the real-estate market on the other, requiring both a critical, political and technical re-appraisal from the architectural profession city managers.

DIGITAL REAL ESTATE

In a world where facilities are required to run 24/7/365, where availability demands range between 99.67% and 99.99% (downtime is valued at £6,5 million per hour in the case of a financial brokerage operation), where structures need to sustain loads of up to 15 kN/sq m, where mid-size facilities with a 250kW UPS can be expected to spend £200,000 PY on power, it is clear that we are facing extreme infrastructure demands.

At the scale of a city block or individual building, reference to existing form still proliferates in this nascent transformative scenario. Similarly the cartographic dimension found in abstract art and decorative fascination of parametricism will not in itself generate a new aesthetic to influence public perception. Our response is to combine analogue skills with augmented reality to shift architectural composition away from a two dimensional plan generated process, to connect the physical construct with digital content, avoid interiorisation and understand how we move through built space.

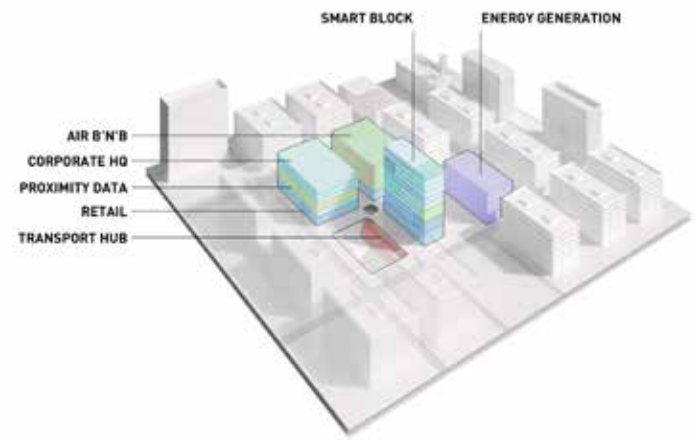
DATA CENTRES

To fully understand the potential of DRE, specifically data centres, energy centres and smart blocks, we first need to acknowledge a shift in value, that both capital investment and revenues for a data centre can be up to fivefold the usual rates associated with corporate office space construction and rental. This alone places these facilities as a key player in the real estate market, a factor which cannot be overlooked. In 2013 a total supply of 34,000sqm of technical space (data) in London was equivalent to the 2007 peak prior to the financial crisis. As the trend increases we can foresee a scenario where such developments will increasingly lead corporate investment in the built environment, and in turn demand change from a regulatory framework incessantly catching up with a fast market trajectory. Capital-intensive operations linked to the development of tech-heavy projects generate more money for national and local governments than labour intensive operations such as call centres or the general service industry. Once local planning authorities switch onto this phenomenon rather than attempt to contain it and re-focus their policies from mere job headcount to the creation of opportunities for highly skilled employment, we may see a further increase in technology-led development across urban and peripheral environments wherein data centres become a catalyst for new urban relationships. This is a challenge not only for the AECO industry but also government and corporations as we escalate from edge to hyperscale facilities. Considering supercomputer cooling trends it is likely the ambient temperature within data centres will rise beyond

30 degrees centigrade pointing to increased automisation without increasing PUE as exemplified by our current design for a tall data centre in Hong Kong where the likelihood of cooling chips at source within performance envelopes developed from bio-mimicry will utilise composite materials to counterbalance an increase in skeletal strength. In this scenario we envisage robotically maintained data centres running hotter.

With fibre services now moving from 10Gbps to 100Gbps uninterrupted power supply remains crucial to keeping the world online.

Whether in a suburbanlocation, self reliant on its off-grid energy production and data storage (Interxion's Campus, Frankfurt), an urban development recovering energy from →



a data furnace (Telehouse West, London) or a research campus powered by a High Performance Computing facility (MareNostrum,Barcelona) what is at stake is the future of our productive landscapes determined by big capital investments, algorithms and efficiencies contributing to the progressive development of a new European industrial culture. What is clear however is that non fossil fuel sources of generating electricity such as wind wave and solar power which have enjoyed significant subsidy will not generate sufficient megawatts to prevent downtime. Nuclear fission can provide significant quantities of carbon free power particularly Small Modular Reactors (SMRs) which have the potential to provide efficient, rapid deployment of electrical power where it is required.

ENERGY FROM SMRS

In order to continue and grow the deployment of nuclear power a complete rethinking of the design, construction, licensing and operation is necessary, capable of delivering a modern deployable fully scalable Modular Urban Nuclear Reactor. To do this several engineering and architectural challenges have to be addressed to gain regulatory approval and public acceptance. How Small Modular Reactors (SMRs) are designed will be the key determinant in changing perception of what is safe energy. The impact of such a breakthrough in gaining public acceptance will provide the platform for co-locating resilient power facilities with the new urban mix of real estate where innovation, advanced manufacturing, research and new forms of commerce increasingly take place. It will locate sentient power blocks in urban areas as opposed to sensitive rural locations. Importantly it will enable advances in technological and material science to be fully exploited in design and construction.

Research within MIT, FMAC and other bodies indicates that technical solutions exist, based for example on Molten Salt or Liquid Metal fuel reactors, which can produce 50-100MW of electrical energy in a compact footprint, with intrinsic safety and could provide the base for a deployable Modular Urban Reactor, without the technical and planning constraints associated with size and complexity of existing plants. Currently most commercial ventures investigating SMRs are focused on converting existing technology from maritime use or designing multiple reactor facilities based on existing low power density concepts. The consequence of this technology driven approach is likely to create installations which are rural/coastal located and encounter the same time, cost, environmental and planning approval challenges of large scale plants. What is novel in the MUR approach is to start from a market perspective, i.e. where is demand located? what advantage

can be gained from proximity and automation? what is the optimum size for manufacture and operation? How can positive public perception be achieved? This approach aligns with the urbanization of innovation leading to intensification of real estate, mixing industrial, office, research, ultilities and lifestyle in close proximity, generating smart approaches to organizing and managing cities. The Modular Urban Nuclear Reactor introduces a number of key novel solutions:

1. Fully autonomous remotely controlled nuclear power plant
2. Factory built, additive manufacturing based sealed transportable reactor
3. Fully sealed and autonomous post design base accident configuration
4. Full-envelope testing based licensing

The completely novel concept introduced in 4, is key to fast deployment and continuous improvement, and greatly supports the aspect of public acceptance. Three dimensional design and simulation methods, coupled to innovative materials will be key in addressing core design with low-enrichment fuel, particularly challenging for a small footprint reactor. Autonomous operation, will introduce new challenges, but also great opportunities. Architecturally defining building configurations which accommodate human, automated and technological developments allied with an ultra lightweight structure (by comparison) to optimize form, cost and construction as well as facilitate advocacy will be paramount.

CLOCKWISE FROM LEFT
Smart Block - Source: Scott Brownrigg
Telehouse West London - source Nick Rochowski

SMART BLOCK

If the Smart City is increasingly defined as the management system of urban data (software), we see the Smart Block as the physical enabler (hardware) of the contemporary digital urban ecosystem. The Smart Block is a dense city node concentrating innovators, transport, machines and infrastructure in one place. It enables to unlock development beyond the twentieth century segregation of industrial land from city life in so much as it aims to transform the perception of contemporary production through the innovative architectural resolution of its envelope.

The Smart Block proposition grows from the recognition that technology and innovation are becoming an increasingly urban phenomena. "For the past 50 years, the landscape of innovation has been dominated by places like Silicon Valley—suburban corridors of spatially isolated corporate campuses, accessible only by car, with little emphasis on the quality of life or on integrating work, housing, and recreation. A new complementary urban model is now emerging, giving rise to what experts and institutions have been calling innovation districts." (Katz & Wagner, 2014, p.1). These districts, by the 2014 definition of the Brookings Institution are "geographic areas where leading-edge anchor institutions and companies cluster and connect with start-ups, business incubators, and accelerators." Barcelona 22, Boston Innovation District, Buenos Aires Distrito Tecnologico, Medellinnovation District and London Tech City are the most notable examples of this important global trend. As Cohen puts it "given the strong connection between high-growth, high-tech start-ups and economic development and job growth, it is no surprise that the current shift from suburban to urban tech ecosystem has started to attract significant interest between in governance structures, real estate developers and urban professionals."

Our value proposition for the Smart Block envisions a scenario in which the geography of innovation is defined by the localisation trend of both IP and new technologies, essential for a digital economy to thrive and scale up.

At an urban level the Smart Block has the potential to unlock development within industrial land allocation. Our research has generally found that the largest components of industrial land demand tend to be big B8 or B2 sheds, which are usually not compatible with mixed-use development, as they require 24 hour operational access and are noisy. However past experience in the data and energy sector suggests Smart Block could prove as a disruptive element in the traditional attempts at mixing production, living and recreation within urban environments. The emergence of technologies such as DC free-cooling (ie less energy hungry and less noisy) and energy generation such as SMRs will impact strongly on the opportunities of merging populated environments in close proximity to the infrastructure essential to a global economy.

As a self-contained urban element the Smart Block responds to a new form of urbanity for the digital economy which has been described as a clustered network.

At an architectural level, our focus on building design and performance envelopes will reflect and give form to today's reality of "bits and bricks" where networking, infrastructure and space are intertwined. If digital design and fabrication are restructuring production spatially, functionally and socially then to paraphrase Carlo Ratti: →

Smart Energy
Ai
Data Storage
E-Commerce
Drone Port
Clean Tech
Smart Mobility
Robotics
Retail
Co-Work
Fin-Tech
3D Print

"Our role as architects is the choreographer of dynamic and adaptive forces rather than scripting outcomes in a deterministic way."

The envelope of the Smart Block becomes an active interface for both human and non-human factors. In parallel to its ability to actively control fluid dynamics and environmental exchanges it is an active element for the reconfiguration of spaces and perceptions. This becomes not only necessary in terms of its public acceptance which leads to real estate value, but also for architecture to be able to communicate and adequately reflect and attract values and lifestyles of its future users.

Today's teenage generation loves to make, invent, and design things, as a way to be heard. "They, (13-21 years old, labeled Generation K) do not know any different. This is their world – this digital ecosystem is their normality". Despite being constantly connected to friends via social media, Generation K are deeply lonely. 80% said they prefer hanging out with friends face-to-face, rather than online. Hertz remarks "Physical interaction comes at a premium in this digital world,"

Typical top-down planning policies may not be sufficient to disrupt the polarisation of growth and production given current environment of "market realism". In order to reposition ourselves as agents of change, a different more entrepreneurial attitude will be requested: this could mean a much closer relationship with the customers (ie technology provider and tenants) to identify new high-value building types and technologies able to generate both positive ROI for developers and place-making.

The unifying element of this new reality travels at 186,000 miles per second ●

ABOVE

Smart Block - Source: Scott Brownrigg

Small Modular Reactor – Source: Scott Brownrigg

GLOSSARY

AECO
Architecture, Engineering, Construction and Operations, (AECO) industry represents the integrated approach for project delivery across disciplines and building life-cycles.
AI: 'Artificial Intelligence' describes the actuality whereva machine mimics cognitive functions associated with human minds, such as 'learning' and 'problem solving'.

CLOUD-SCALE
When software applications are built as distributed systems (The Cloud), every aspect of its supporting physical environment, from server design to the building itself creates an opportunity to drive systems integration for greater reliability, scalability, efficiency, and sustainability.

COLO
A colocation data centre providing lettable space, power, cooling, and physical security to retail customers.

DF
A Data Furnace (DF) is a strategy by which a large amount of heat from cloud scale data centres can be distributed to buildings typologies and used as a primary heat source.

DOWNTIME
Downtime is used to refer to periods when a critical facility is unavailable. The financial impact of a major system outage is enormous eg $6.5 million per hour for a financial brokerage operation, $2.6 million per hour for a credit card authorization system, $14,500 per hour for an ATM. DR: Disaster Recovery (DR) is the process by which a system is restored to a previous acceptable state, after a natural or man-made disaster.

DRE
Digital Real Estate (DRE) expresses the hybridization of data and energy infrastructure and productive architecture.

E-INFRASTRUCTURE
The advanced computational capacity of a state, addressed as a complex system of public-private partnerships, soft-ware, hardware, networks, data storage and skills.

E-SCIENCE
Data generation and analytics using computational methods are at the heart of all modern science and technology. E-Science can be defined as the discipline of using digital methods for generating ideas and knowledge on healthcare, biotechnology, transportation, energy, and climate modelling.

HA
High availability (HA) is the measurement of a mission critical facility to remain accessible in the event of a system component failure (i.e. no loss of service).

HPC
High performance computing (HPC) refers to the use of leading edge computers for simulation, modelling and advanced data analytics.

LATENCY
The factor expressing the connectivity speed directly dependent from the physical distance between servers. Low latency drives city localisation of data infrastructure for the financial sector.

MACHINE LEARNING
The capacity of a computer to learn from experience, i.e. to modify its processing on the basis of newly acquired information.

MISSION CRITICAL
The AECO sector dealing with facilities whose failure will result in the failure of business operations.

PRODUCTIVE ARCHITECTURE
A pattern of architectures, overlaying brands, manufacturing, infrastructures, power generation, data networks, art and science. The building blocks of 'digital real estate' where urban environments, leading edge consumerism and infrastructure co-exist in close proximity.

PUE
Power Utilization Effectiveness (PUE) is the industry standard measuring unit for efficiency and expresses the relationship between total power into a Data Centre and total power delivered at the rack eg.1.15.

SENTIENT ARCHITECTURE
An architecture that can record, correlate and anticipate.

TIER
A standardized methodology defining the uptime of a data centre. Costs increase exponentially as the probability of down-time decreases eg Tier I 99.67% availability Tier IV with 99.99% availability.

TTM
Time to market (TTM) is the length of time required from design through construction to operation. TTM in critical facilities is important given the speed of facility obsolescence.

UPTIME
Uptime refers to when a data centre is in operation and available.

ACKNOWLEDGMENT

We would like to acknowledge the smartness and nuclear contributions respectively of Tommaso Franzolini and Prof. Emilio Baglietto

Building Study: The Spark, Southampton Solent University

We experience architecture dynamically. Our understanding and appreciation of buildings evolves and changes as we move around the buildings and within them. As Director Ian Pratt explains here, this is particularly true of The Spark at Southampton Solent University which was specifically designed with interaction and the science of people movement in mind.

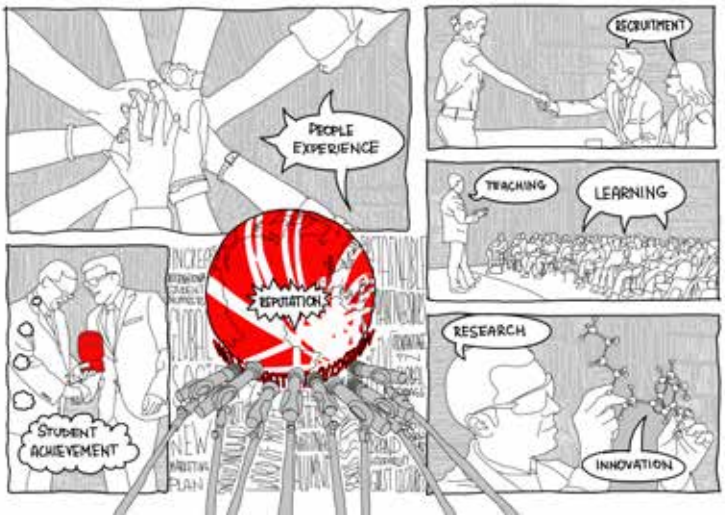
The completion of The Spark in May 2016 marked the culmination of an incredibly rewarding, four-year journey to identify, inform, illustrate and deliver Solent's vision for teaching and learning.

The project was conceived as an academic hub and a showcase for excellence in learning, teaching, research, innovation and student achievement. As a vehicle for institutional change it has totally transformed the student, staff and visitor experience.

The design skilfully brings together spaces for learning, teaching, work and play It promotes interdisciplinary activity and collaboration by encouraging students, academics, visitors and the general public to mix and interact.

Accommodation is arranged over seven storeys around an impressive, full-height atrium space with a stunning 'Solent Red' pod at its centre and a high definition digital media wall at the far eastern end.

"The building's huge, attention-grabbing central atrium has brought a genuine, wow factor to the campus, and will enable us to strengthen our connections to local and regional businesses and community organisations through exhibitions, conferences, events and social functions."
Professor Graham Baldwin – Vice-Chancellor – Southampton Solent University.



ABOVE
Sketch illustrating Solent's Logo and strategic priorities

OPPOSITE PAGE CLOCKWISE
View of atrium and pod from entrance
Fashion show July 2016

"In just a few months, it's played host to our degree shows, international events, Christmas celebrations and more. It's providing students with a dynamic new space in which to study, socialise and share learning experiences."
Great Strides 2016/17 Issue One – Southampton Solent University

The atrium connects new facilities to the north with the existing Sir John Everett Millais Building to the south and functions as a major arrival space, social learning area and a venue for large events such as gala dinners, exhibitions, fashion shows - previously, there was no significant congregational space on the campus for this.

Overall, this £33 million, 10,000 sq m, BREEAM 'Excellent' rated, city-centre development provides Solent with a 'mixed economy' of innovative, centrally timetabled, general teaching and learning spaces comprising 35 classrooms, 5 lecture rooms, 2 lecture theatres, along with a café, conference centre, kitchen, fine dining and bar area.

ACTIVATING AND ENRICHING SPACE

The Spark is activated by people flowing through the spaces, by their interactions with each other and with elements of the building. Individual and collective experiences differ from day-to-day and from day-to-night.

The atrium and surrounding spaces are enriched by ambient light introduced by the long linear roof-lights which from time-to-time reveal clouds passing by on the prevailing south westerly breeze.

Eye-catching sunlight and shadow patterns animate the atrium walls and the glazed main entrance 'brings' the Grade II Listed East Park 'into the building' – connecting occupants to the outside world and to the passing of the seasons.

Movement of the trees, people in the park and atrium are reflected in the high gloss finish of The Pod which appears to glow red at night as light emanates from the building.

SEE AND SHARE

The design uses transparency and openness to promote movement and to encourage people to see and share learning and teaching experiences, knowledge and research. To aid user orientation and way-finding, key destinations are visible from the atrium and between floor levels. Circulation arrangements are clear, simple and on show.

The upper floor level horizontal circulation routes are designed as open gallery walkways with glass balustrading - linked vertically with an open feature staircase. This arrangement further animates the atrium with people movement, maximises natural light penetration, the sense of space, openness and connectivity and ensures good passive surveillance of all areas.

SHIFTING PERSPECTIVES

It is only by moving around The Spark that it is possible to fully understand and appreciate the nature and synergy of the different elements which give the building its dynamic, engaging and uplifting character.

Moving inward from the main entrance, building users are offered changing views of key elements such as The Pod, the theatre steps leading to the podium level lecture theatres, the bridges, the upper floor balconies and 'window-boxes' and fleeting glimpses of the 'super-graphics' beyond-the pristine white screen walls. →

ABOVE
View of atrium and informal learning area

OPPOSITE PAGE
Main entrance from east park terrace

In contrast, building users walking along the upper floor levels', open gallery walkways are able to examine The Pod in closer detail, gain an overview of activities within the below atrium and look out over the tree-tops in East Park to the Civic Quarter beyond.

All the while, moving images on the large HD digital media wall add to the sense of activity and interaction and provide insights into the full academic life of the university.

RE-ACTIVATING AND ENERGISING EAST PARK TERRACE

> "Passers-by stop on the pavement and in the park to gaze at The Pod."

The Spark celebrates and strengthens the relationship between Solent and the City of Southampton. The design echoes the quality, scale and sense of permanence imbued by nearby civic buildings such as the Guildhall but is also welcoming, ambitious and dynamic.

Floor- to- ceiling windows to the north and east provide a sense of openness, reveal movement and activity and create a strong visual connection between building users within and the wider public outwith.

The glazed main entrance addresses the Grade II Listed East Park and reactivates and energises East Park Terrace throughout the day and into the evening.

This reinforces the ideological integration of the university and helps to increase pedestrian movement along East Park Terrace and through East Park - with significant pedestrian safety and security benefits.

REMOVING BARRIERS TO MOVEMENT

The design resolved major level differences to achieve comprehensive barrier-free access to new and existing facilities. Importantly, it also significantly improved access to passenger lifts, staircases and sanitary provisions from within the existing building.

Within The Spark, individual spaces are designed with wheelchair users in mind, featuring height adjustable tables which have been seamlessly blended throughout. As a result, The Spark is believed to be one of the most universally accessible buildings in the sector.

APPLYING THE SCIENCE OF PEOPLE MOVEMENT

The Spark can accommodate 2,600 people at full capacity. However, the facilities are used by all 5 of Solent's schools, resulting in a higher proportion of use by the 10,000+ (full time equivalent) students most days. This meant the design had to be able to cater for very large movements of people between timetabled teaching and learning periods.

With this in mind, Scott Brownrigg commissioned Buro Happold's SMART Space team to assess the evolving design with a particular focus on how the proposed horizontal and vertical circulation arrangements might perform during normal timetabled operation and how the design might be optimised.

This input proved to be highly beneficial and has resulted in a building that is both highly efficient and congestion-free when used at maximum capacity.

The assessment comprised of data gathering, then - studies to identify 'pinch-points', - together with full agent-based, dynamic modelling of different scenarios utilising Scott Brownrigg's Level 2 Building Information Model (BIM) and Buro

Happold's SMART Move software. This approach facilitiated rapid analysis of potential design refinements.

The assessment activities were undertaken in dialogue with members of the Scott Brownrigg team and considered activity patterns and people flow rates associated with three 'peak pressure' scenarios - morning arrivals, class changeovers and end-of-day departures.

To ensure the assessment was as accurate as possible, key operational assumptions were first tested and agreed with Solent's timetabling team. For example, the agreed assumptions for the class changeover scenario were as follows:

- 100% space utilisation – something which is unheard of in the sector
- 10% of the students have a double lecture and hence do not move
- 50% of the students move from one lecture to another in the Spark
- 40% of students leave their classroom and exit The Spark
- 35% of students arrive from outside and go to their classroom
- 5% of students go from the cafe to their classrooms
- 75% of the arriving students are expected to arrive within 6-8 minutes before the lecture time and the remaining 25% of students are expected to arrive within 1-2minutes
- Within the departure profile 50% of the classes are assumed to finish within 5minutes before the actual lecture end time and the remaining 50% of classes are assumed to end within 5 minutes after the lecture end time
- Possible queuing of students outside the classrooms (prior to lecturer arrival) is considered in the modelling

For each 'peak pressure' scenario, it was assumed that 100% of the students would use the staircases for vertical movement – an unlikely worst case assumption that discounted the three passenger lifts.

Assessment findings and recommendations were presented in a series of written reports, illustrated with visual density maps along with animations exported directly from SMART Move.

The final assessments concluded that the overall circulation arrangements were well laid-out in relation to the intended functions of the building, though specific recommendations were made to help maximise comfort and minimise the risk of congestion during peak periods. These included:

- Increasing the capacity of the main entrance door array
- Moving the staircases at the eastern and western ends inward by one structural bay to optimise access and people flow
- Increasing the clear width of the upper floor level open gallery walkways from 2.0m to 2.5m
- Increasing the clear width of the staircases beyond the minimum width required for means of escape

The assessment also endorsed the proposal to add a range of gallery, balcony and 'window-box' break-out spaces to the upper floor level gallery walkways.

The most captivating, dynamic and photogenic element of the design is The Pod. The concept for this was born of early discussions about Solent's spark logo and what it symbolises. Just like Solent, this curving three-dimensional form is bold, confident, ambitious and very distinctive. One of my favourite post-completion moments to date was watching a four year old boy walk into the Spark with his parents one Saturday morning – stopped in his tracks, arm outstretched, and head craned back, beaming from ear to ear he shouted excitedly at the top of this voice:

"Look mummy a space-ship."
Young Child

However, The Pod's shape and position is intentionally ambiguous, allowing building users and visitors to draw their own conclusions about its purpose and meaning.

"A piece of sculpture can be purely abstract or non-representational."
Barbara Hepworth

"When people walk through the door they stop very abruptly, look at the Pod and simply say wow."
Professor Graham Baldwin – SSU Vice-Chancellor.

Some view The Pod as an expression of Solent's maritime heritage, others see a futuristic craft from another world, and some feel it resembles the seed of the Saga Bean Tree – given as a symbol of love in China. Stepping inside has even been compared to boarding a submarine – "with the doors closed, the acoustic separation is so good you feel like you're under water".

Whatever the analogy, the important point is that this distinctive sculptural element elicits an emotional response. On a daily basis, people are engaging with it and pausing for thought or perhaps a photo or two as they move around and within The Spark.

The University is delighted with the building which is enhancing Solent's brand and position, helping to attract students in what has become a highly competitive recruitment market ●

Building Study:
The SSE SWALEC Stadium and the Ice Arena Wales

The very essence of sport presupposes movement. A stadium – a theatre of sport – actually contains two performances which often occur simultaneously. There is the one on the field of play, and the responsive or reactive one from the audience – the spectators.

We shall discuss how this dual performance or sporting 'dance' can be facilitated by the configuration of the stadium later.

First we will look at the prologue – the very act of arrival and how this consideration effects the organisation and planning of the SWALEC Stadium.

The first part of the stadium was developed in 1999 for the Cricket World Cup with the client Glamorgan County Cricket Club (GCCC). Cardiff was selected as home to the Australian team (tournament favourites) and the ground had benefited from the largest Sport Lot donation of £3.6M which had delivered a new National Indoor Cricket School, hospitality facilities, administration and 1,800 permanent fixed seats. The remaining 10,000 seats where all provided by temporary terraces.

Cardiff hosted two World Cups that year (and still the only city in the world to do so in the same calendar year); both cricket and rugby. The city and the club were focused on making as much profile (and money) from both events.

The placement and disposition of these first elements were conceived as part of a longer term masterplan which would enable the SWALEC to host future test cricket matches.

The indoor school was very much conceived as 'state of the art' – it followed closely behind the indoor school at Lord's (designed by Morley Associates) and provided a seven-lane fully netted hall which was also capable of holding functions for 750 people at a banquet. The rest of the ground floor was taken up by four changing rooms (designed to meet Sports Council Guidance for 22 players in each), a fitness suite, physiotherapy and medical facilities, offices and a club shop specialising in cricket goods and GCCC club merchandise. The upper levels provided coaching and viewing balconies, restaurant and dining, kitchens, GCCC offices and corporate hospitality. The roof above the hospitality block was designed as a huge roof terrace with great views over the square, covered by a tensile structure.

Perhaps the biggest design consideration was to make the indoor school naturally lit. To play cricket at an international level, you need 1500 lux of light at the batting crease. Through the use of a saw-tooth roof which facilitated north light combined with a series of internal 'sails' to diffuse the light and avoid specular glare, this exacting criteria was achieved. The additional benefit was a 60% reduction in the club's energy bills from their previous facility, as they were no longer reliant on huge quantities of artificial lighting.

More romantically, the design included two huge aircraft hangar doors. These could open up the entire main hall to the square, bringing in air and the early spring smell of cut grass, to a functional space that is usually sweaty and introspective.

The structural system created to achieve this roof profile, was designed as an abstraction of the trees within the stadium's unique Grade II listed park setting. From both outside-in and inside-out, the interplay of the natural and the abstraction is clearly legible through the clerestory light that separates the roof from the wall, creating a floating visual delicacy.

However, as these elements were the first part of the overall development (because they were fundable and commercially viable) but were only smaller parts of the overall masterplan, these would shift the centre of gravity, albeit for a known period of time, away from the natural and designated points of entry and creating a diffused sense of arrival.

The next phase of development enabled this imbalance to be addressed.

GCCC and the city council had ambitious plans to host an Ashes Test – that historic cricketing battle between England and Australia. To do this, the stadium had to meet the essential criteria set down by the England and Wales Cricket Board (ECB) and the Test Match Status This included requirements such as 15,000 permanent seats of which 10% had to be covered, a media centre to facilitate 200 press members, TV and Radio studios, outside broadcasting facilities, test officials accommodation (Third umpire, TV replay etc) and ancillary accommodation.

This quantum of development enabled the overall masterplan to be completed. A new members and players pavilion, the media centre and two new grandstands were

ABOVE
SSE SWALEC Stadium

created– placing main entrances that would address the public realm. The vision even included a new waterbus station on the River Taff – allowing spectators to arrive by boat from hotels in Cardiff Bay. The complete sequence of arrival through the Grade II listed parks of Bute Gardens, Sophia Gardens and Pontcanna Fields would be an important part of the spectator experience – the commencement of the performance.

So we use linear spaces for movement and static spaces for of moments of rest – the gathering of the crowds and the accentuation of excitement and expectancy.

The connection between the landscape context and the configuration and concept was fundamental. Therefore, rather than being a complete stadium 'bowl' – typical for contemporary cricket facilities particularly in the southern hemisphere – the SWALEC is a series of pavilions joined by a skirt of seating, with higher grandstands that accentuate or hide parts of the ground. This castellated profile allows the parkland landscape in and a viewed prospect out.

Whilst there are obvious similarities in some design principles across all sporting stadia, the general use of a cricket stadium has some fundamental differences from its football or rugby cousins. The Safety at Sports Grounds Act 1975 (commonly known as the Green Guide) is the bible of design principles that govern specific requirements for a large number of the elements that constitute the stadium. It is applicable to grounds that have a capacity of 10,000 seated spectators or over.

The first major difference is that in most cricket matches (Twenty20 games excluded) are longer and have natural break periods (bowling change of ends, fall of a wicket etc) and often 45 minutes for lunch. Even the bish-bash of the Twenty20 games has some of these breaks. This takes away the crowd rush and pressure on ancillary facilities (particularly toilets) in the 15 minute half time break for football and rugby.

Equally because of the length of the game, spectator arrival is more relaxed and casual, although this has a different effect on movement around the stadium which we explain later.

The second major difference is viewing time. A Twenty20 game lasts for around three hours which is the shortest format, but normally a day's cricket is 6-7 hours. The consequence of this is that seats and seat spacing (including terrace goings) are more generous. There is no necessity for crowd segregation either, which has a significant effect on spectator movement (although the SWALEC has been designed to accommodate spectator segregation). Get these wrong, and you have the unpleasant consequences such as those that have troubled the new London City stadium (previously the Olympic Stadium) as West Ham's new ground has seen sadly evidenced in its early use.

The drama of arrival is an important part of designed movement flows. It is generally considered that to arrive at an upper level and then migrate downwards, reveals the pitch or the sporting theatre in a way in which enhances that arrival experience. Unfortunately, the budgets at both the SWALEC and Ice Arena Wales (IAW) allowed this movement pattern – there was no natural topography that facilitated this particular sequence, even though the IAW was conceived as having a first floor arrival, this was sadly "value engineered" out.

However, within the two main stands at the SWALEC, this arrival sequence was manufactured by the use of vomitories. These stair devices lead you up from the ground floor concourse from where the oval is still hidden. The flight takes you up half a level at which point you cross the threshold from the enclosed space of the concourse to the open bowl of the oval. This transition is a key aspect of that sense of arrival – that sense of theatre.

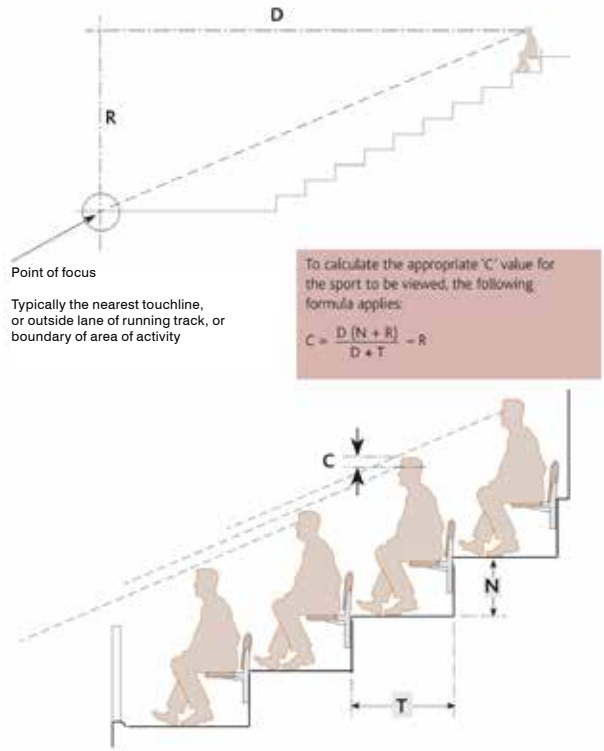
There is an ebb and flow between when the crowd inspires the players and when the players inspire the crowd. This is facilitated by several things – acoustic properties are important, but good sight lines and an unobstructed view of the action, combined with a terraced section that provides those good sight lines but with physical intimacy to the playing area, are perhaps even more significant.

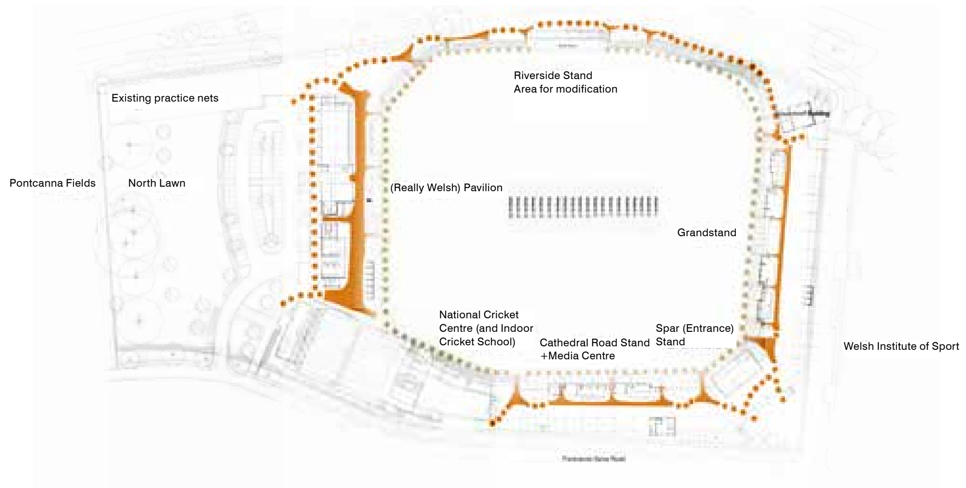
Here, the Green Guide again provides useful design criteria for establishing a good spectator experience.

The measurement is called the 'C' value and is calculated by using the following diagram. →

KEY

C The 'C' value
D The horizontal distance from the eye to the point of focus
N The riser height
R The vertical height to the point of focus
T The seating row depth




Riverside Stand
Area for modification
Existing practice nets
Pontcanna Fields
North Lawn
(Really Welsh) Pavilion
Grandstand
National Cricket
Centre (and Indoor
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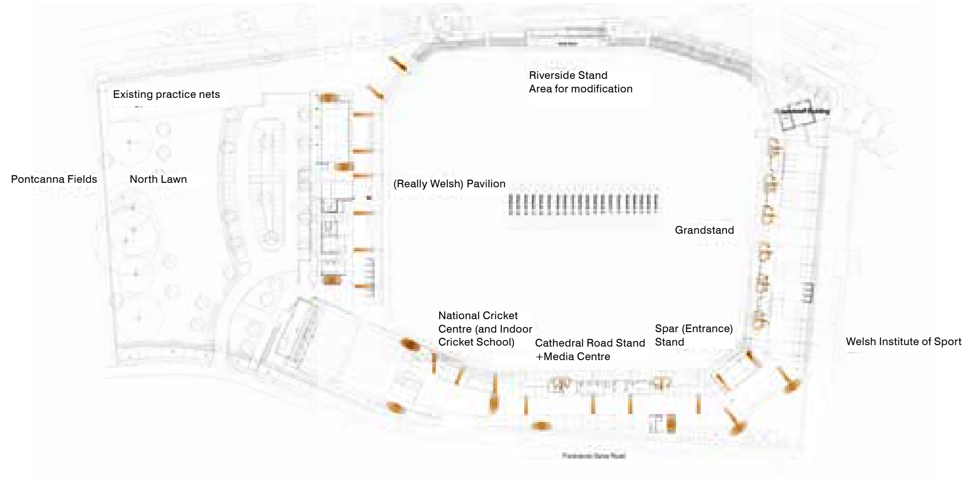
Cathedral Road Stand
+Media Centre
Spar (Entrance)
Stand
Welsh Institute of Sport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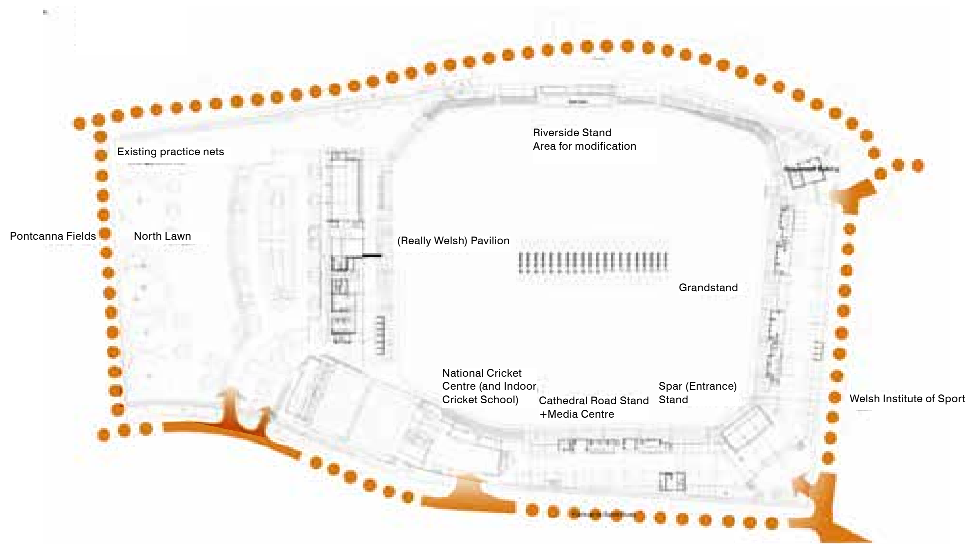
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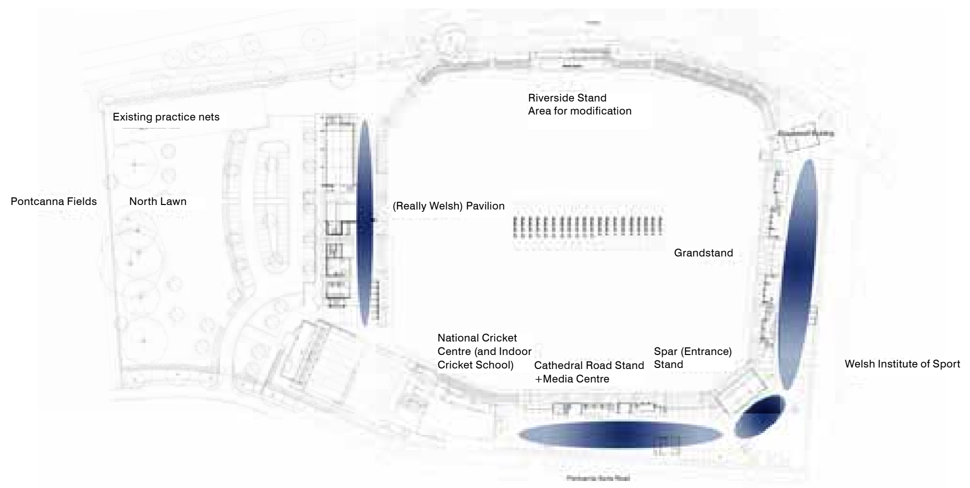
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Stand
Welsh Institute of Sport

ABOVE

Ice Arena Wales Interior

Ice Arena Wales Exterior

OPPOSITE PAGE

Circulation diagram 1

Circulation diagram 2

Ingress diagram

Concourse reservoirs diagram

In both the SWALEC and IAW, they enjoy an excellent 'C' value and even in the case of the IAW, where because of the crash boards around the ice, proximity to the action and sightlines are exemplary.

The pragmatics of people flow within the stadium fabric can be assessed on a simple level against the following design criteria (again, as defined within the Green Guide);-

- Entry capacity – determined by the number of persons capable of entering the ground in 1 hour – 660 people per turnstile per hour
- 10% of the ground can be "unreserved seats"
- Stair widths – 1.2 – 1.8m (1.2 preferred)
- Concourse capacity – 20 persons per 10 sq m
- Reservoir exit – 40 persons per 10sqm
- Stepped exit – 66 persons per minute per metre (width)
- Flat exist – 82 persons per minute per metre (width)
- 95% of the stadium must have unobstructed views
- The stadium must be able to be evacuated to the safe zone within 8 minutes

The playing area can be a designated safe zone but only on a short temporary basis.

Even given the above, the way in which any stadium or arena operates in terms of movement requires careful consideration of both the pragmatic and the poetic. It must consider the arrival sequence that starts long before turnstiles, the way in which the players enter the field of play, the interaction between the crowd and the players – all are participants in the theatre and the performance.

The IAW has been well received by the fans of the Cardiff Devils as well as visiting supporters. The SWALEC Stadium was voted in the top three sporting venues in the UK by both the public and industry experts immediately after the first Ashes Test, alongside Wimbledon and the O2 Arena ●

Design Process:
Metro Urban Density – A collaborative exploration into future Cardiff Capital region Metro sites

On the 24 September 2016, 70 professionals and practitioners came together to explore how the new Metro proposals for the Cardiff Capital Region might stimulate the future improvement and development of communities across southern Wales. Scott Brownrigg was a key sponsor of the event. Here we summarise the outputs from the day and the subsequently issued report.

The MUD:Metro Urban Density was an event initiated by the Design Circle, the southern branch of the Royal Society of Architects in Wales (RSAW). Run for and by architects, built environment consultants and designers with the aim of working collaboratively to think creatively about the development and benefits that the new Metro system could bring to the Cardiff Capital Region.

The system is set to be the largest transport infrastructure project in the City Region in a lifetime, transforming the way people travel across the region, providing faster, integrated services using trains, buses, light rail and active travel (walking and cycling). The first phase of the programme is underway, with the second phase from 2017 to 2023 at the planning stage. A long term incremental expansion is planned thereafter.

The First Minister, Carwyn Jones stated in March 2015:

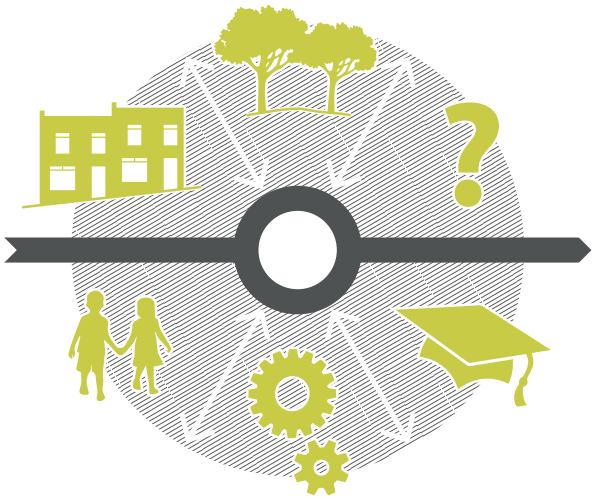
> "This is a game-changing project and it cannot be done in a half-hearted way…we fully understand this is a once-in-a-lifetime opportunity that could transform the economic prospects of up to one million people in Wales."

OPPOSITE PAGE

Metro station locations

BELOW

Graphic showing Metro station community considerations



The one-day MUD event asked designers, artists, planners and engineers to unite with members of local communities to analyse the opportunities created by the Metro and discuss how these could best serve local needs. The brief set by the Design Circle was to:

> Show that the Metro could be a huge opportunity for making the whole City Region a more vibrant, diverse, pleasant and interconnected set of unique and enjoyable places.

MUD looked at six potential sites for key Metro stations, exploring their history, character and function and how these new stations might promote development and regeneration of communities across the region.

Participants were divided into six teams and each given a potential metro station site to explore and visit. Teams were asked to identify:

- The biggest benefit that their vision could deliver for local people, land owners, the local council and the Welsh Government
- Actions the local council or the Welsh Government could take with the land they own (or other routes they control) to support the outcomes proposed
- The biggest barrier to their vision and how it might be overcome

The sites were:

- Caerleon, Newport, on the Marches Line to North Wales and Manchester
- Cogan, Vale of Glamorgan, on the Barry Line
- Nelson, Caerphilly, on a freight line off the Rhymney Line
- Pontypridd Goods Yars, Thodda Cynon Taff, on the Merthyr and Aberdare Lines
- Tredegar Park, Newport, on the Ebbw Valley Line
- Wedal Road, Cardiff, on the Rhymney Line

The below provides commentary and recommendation overviews for each of the six sites:

CAERLEON

Caerleon was perceived as a town with considerable potential that is underperforming. The station could be a key catalyst. Redevelopment opportunities should aim to build on the distinctive character of the town, with lots of green spaces already adding to its heritage value. New links form the station should aim to reinforce this green character. Festivals and markets could be attracted to make use of the open spaces.

Caerleon Metro could provide the catalyst to break down physical barriers with increased permeability for visitors and residents alike. Appreciation of Caerleon's history and future potential for wider networks (NHS and University) could lead to economic prosperity within the area.

COGAN

Utilising the existing topography in challenging both heavy and light rail solutions could provide Cogan an opportunity to connect people on various levels in an area currently dominated by the car. A network of sustainable modes of travel can promote healthier streets providing a more attractive community and leisure destination for all.

There was a sense that Cogan had lost some of its identity as a community. A new/remodelled station could become a new focus. With a mixture of uses already in the vicinity there is potential to widen this, perhaps attracting hotel, evening economy and small-scale retail uses.

NELSON

The Nelson Metro station offers the opportunity to experience the beauty and heritage of our landscape and one that looks to providing environmental tourism, sociability and connectivity for communities and visitors alike.

As a small town, it needs an approach involving lots of small-scale improvements. Engagement with the local residential and business communities would be important. Being on the edge of the town, the station could become a destination for countryside recreation.

PONTYPRIDD

Pontypridd is a historical town that connects the Valleys communities, not only geographically, but historically and economically. The town craves progress to feed back into the socio-economically deprived areas to the North and the development of the goods yard site into a Metro Hub servicing Pontypridd and subsequently, the wider Valleys district which will help embrace growth, employment and diverse education opportunities.→

There is potential for the Metro to strengthen Ponypridd's role as a focal point, and for a new station to act as a catalyst for remodelling the town centre. Despite its townscape quality and heritage, the centre was perceived as underperforming.

TREDEGAR PARK

Tredegar Park is strategically in a promising location. Whilst the Metro can encourage the erosion of barriers between communities and amenities locally, by creating links to important heritage, leisure and employment opportunities in the area, it also connects it to the wider economy of the region".

"Better links will maximise the economic potential of the area. The station would provide comfortable links for the local population to job opportunities along the railway corridors, and the numerous businesses and organisations in the Tredegar Park area would become accessible for workers from further away."

WEDAL ROAD

Wedal Road Metro has the potential to create a 'super-park' by combining the cemeteries and Roath parks into a 'health campus' for the University Hospital at Heath, bridging the infrastructure barriers whilst linking to multiple modes of transport.

The site presents the potential for a multi-level station extending across the A48 and Wedal Road, emphasising permeability across road and rail lines as much as accessing the Metro. A large raised public space could be used for pedestrians and cyclists to link Roath Park north and south of the A48 and both elements of the cemetery into a larger network of green traffic-free routes, providing a unique identity as the Health and Wellbeing Metro stop.

Common themes which emerged from the day were:

Have a long-term vision for each station's area

- New/remodelled stations will provide a basis for fundamental change and should be a strong stimulus for regeneration and improvement.
- This requires a strategic, long-term vision for each area. This 'vision' should underpin all decisions affecting these areas from planning to business and service provision.
- Stations can support a higher density of development and a vibrant mix of uses.

Design for the community and movement that we want to achieve

- The public realm around stations needs to recognise critical links from stations to key facilities and deliver high quality and safe pedestrian and cycle links.
- There is a need to overcome the barriers that major highways commonly represent in gaining access to stations.
- The public realm surrounding the stations need to planned as part to the 'Big Vision' and include accessibility for all with barrier-free spaces.
- Station locations have great potential to contribute to wider community wellbeing, integration and productivity. However on-going collaborative engagement with local communities is required.

Use all available means to support Metro's success

Adapt public facilities close to station sites to favour access via the Metro. Relocate main entrances, prioritise Metro signage.

- Drive the links between walking, cycling and associated Metro usage and health.
- Encourage suitable facilities in businesses, leisure and retail service providers to support pedestrian and cyclist Metro usage i.e. storage lockers, changing facilities and solutions for heavy luggage/shopping (encourage 'free home delivery' from businesses).

Each station should have a unique identity

- Stations need to be thought of as journey destinations, focal points and gateways to the local area not simply as origins. Each should have its own identity which links to the area's heritage, history and art.
- Each station should be seen as a catalyst for place-making, refocusing localities and their identities. The 'Big Vision' for each surrounding area should reflect this unique character.
- Stations should assist in overcoming the barriers of railway lines, using physical and visual permeability to enable local foot and cycle traffic to shortcut through stations as well as to use the Metro
- Sites must be pedestrian and cycle friendly, integrating with as many other modes of transport as possible.

The above themes will require the involvement of a number of agencies and mechanisms if the comprehensive agenda for realising the potential of the station sites is to be delivered. Whilst the day focussed on just the six sites, the Metro proposals extend across the whole South East Wales.

There will be the need to engage with local authorities and communities across these regions to maximise upon the wider strategic development and regeneration opportunities that each station can provide to communities which will ultimately help to help to transform the economy and also to shape the region's identity.

Amber Luscombe, a Part II Architectural Assistant at Scott Brownrigg's Cardiff studio participated in the event and helped design the subsequent report. She said of the day:

> The day's event was highly successful with a significant proportion of Cardiff's design community in attendance. The MUD event and report provides a starting point for further conversations to be held and action to be taken regarding the future of the Metro. A MUD manifesto will be issued later this year to key decision makers involved with Metro development ●

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CLOCKWISE FROM RIGHT

MUD logo

Participants at MUD event

DESIGN CIRCLE
RSAW SOUTH

METRO URBAN DENSITY

Design Process:
Education in motion: user-centred primary school chair design

This two-year MA practice-based, design research by Dr Jacqueline Lightfoot FRSA was carried out in response to evidence indicating that school furniture did not afford a good anthropometric fit for the majority of pupils who have to use it; and the potential for this to cause childhood back-pain which, if not addressed, could become chronic in adulthood.

The project's purpose was to address this issue by devising a methodology for designing contemporary school furniture. This was to be achieved by developing a new product with participating pupils. Chairs became the main focus of the research because classroom chairs are the designable artefacts that connect pupils to the school environment. Also, the design of a typical school chair today is based on a 1972 polypropylene and steel classic: Robin Day's Series E (Image 01). Primary school pupils aged five and six years old were the focal user-group; they were chosen because at this age education becomes more formal and schools expect children to sit down for increasing periods of time.

During field research carried out in three primary schools pupils were observed to gain insight on how the existing furniture was being used. To protect children's privacy observations were recorded in drawings. A concurrent literature review investigated posture and back pain to identify task appropriate postures, seeking an ideal to use as a design basis.

Subsequently, four child participants agreed to take part, with their parent's permission, in studio-based prototype development. This was an iterative process; each stage, recorded by video for analysis and interpretation, informed the next stage of development. Participants were given minimal instructions on how to use the developing seat to mitigate premeditated responses. They chose a table-based activity to engage in, for example, drawing or model making, whilst the recording was being made. In this way the research emphasis was on how the seat was being used and captured children's authentic responses.

Periodically a physiotherapist was consulted to interpret visual information from a biomechanical perspective. For example, by sitting on a foot, either when on a chair, or on the floor (Images 02 and 03) children were relieving uncomfortable pressure on their spine. Similarly children, and adults, tilt their seats forwards to make their backs more comfortable. The view that "Good posture is a primitive reflex and pre school children have naturally good posture" (Image 04) arose in early discussions with the physiotherapist. Thus, children's natural responses to the developing seat form became the basis of product evaluation so as to enhance rather than inhibit these instinctive responses.

In addition, three other key factors were integral to prototype development. A significant field observation noted children's natural dynamism (Image 05). This, combined with literature reporting the biomechanical issues associated with prolonged static sitting, brought movement, and ways of supporting it, to the forefront. Also, that Western notions of good seated posture have social and not biomechanical origins drove the quest to explore less conventional seated postures that are more sympathetic to the human form.

The resulting prototype, Situ,* is a one-piece moulded form that moves with the sitter, and affords different ways of sitting (Images 06 and 07). It has an instinctive comfort adjustment, achieved by allowing the user to tilt and swivel and yet Situ has no moving parts. Situ offers an alternative design to the ubiquitous polypropylene chair but the problem of poorly fitting school furniture persists. The research project has since expanded to investigate the social, cultural and design factors affecting primary school pupils seated postures in an Arts and Humanities Research Council funded doctoral study. The resulting thesis "On the Edge of Their Seats: A Human Centred Approach to Primary School Chair Design" was published by the University of Brighton in July 2016. Having been available on the educational market for four years Situ is currently under development in the light of this most recent research ●

* EU Community design registration number 819172

ABOUT THE AUTHOR

Dr. Jacqueline Lightfoot FRSA is a research-led furniture designer creating unique and innovative products primarily for the educational furniture market. Her design ethos takes a human-centred standpoint in that products are developed in participation with representatives of the proposed end-user group: pupils and teachers. In designing this way the end-user's real needs can be taken account of and the resulting products respond to real human issues. She is also a qualified yoga teacher drawing on anatomical knowledge and yogic principles gained through this experience. Studio93Limited was established to bring these products to the market.

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IMAGE 01
Typical school chair

IMAGE 02 & 03
Pressure relief

IMAGE 04
A child's natural 'good' posture

IMAGE 05
A child's natural dynamism

IMAGE 06 & 07
The Situ prototype

Detail:
The Wave Structure Façade, pierhead Street MSCP, Cardiff Bay

Dubbed the 'Coolest Car Park in Cardiff', the Pierhead Street multi-storey car park in Cardiff Bay formed part of the £150m Cardiff Waterside commercial development. The 21st Century design represents the rich nautical heritage of Cardiff Bay. Here Technical Director, Barry Clarke explains how the stunning dramatic light wave effect on its façade was structurally created.

The car park is essentially a simple rectangular structure, 98m long and 20m high. The local geography makes it a prominent landmark within Cardiff Bay, visible over distances from the city of Cardiff itself. As such, it provided a unique opportunity for an iconic statement in support of the Cardiff Bay development, not something that you would think would naturally occur with such a mundane building form. To this end, a sense of movement and visual interest was called for, to the north elevation of the structure.

The nature of Cardiff Bay suggests waves rolling onto a coastal beach, however wave shapes have become somewhat cliché for coastal developments. The design concept developed therefore was for a rolling wave structure, progressing along the façade of the building, with dynamic lighting to enhance the sense of movement:- not so much what a wave looks like, more what a wave is.

The wave structure is created by tensioning a coated mesh fabric over an undulating steel framework, running along each parking level. These waves are layered up the elevation, creating a flowing surface along the length of the Façade.

The impression of movement this gives is enhanced by the use of a rich blue light, washing down onto the face of the individual wave structures. By varying the intensity of the light imposed onto each bay over time through programmable control gear, a peak of the blue light can be made to travel along the undulating façade giving the impression of a moving, rolling wave. By varying this effect from one level of wave structure to another, the entire façade offers an ever changing, moving and gently glowing "beacon" on the skyline of Cardiff Bay.

The length of the façade is broken up into a number of repeating bays. Each bay has a curtain of the white polymer coated high-tenacity polyester micro-yarn mesh fabric hanging down from the slab edge above, tensioned into a part of the wave form by a shaped tubular steel frame projecting from the slab edge below in a gentle arc. This is propped away from the building by diagonally raking tension rods hanging from the slab edge above, keeping the structure rigid enough to tension the mesh fabric.

Varying the length of the tension rods for a particular bay tilts the arc, raising the "hem" of the wave, and varying it's projection along the façade. This is used to create the impression of a single continuous natural wave-form along the building.

By changing the degree and location of the variations from one level of the façade to another, the whole façade is given an organic undulating feel.

Independently controlled twin lamps in a single light fitting are suspended from the raking struts in each bay, to wash the level below with a varying intensity of blue light.

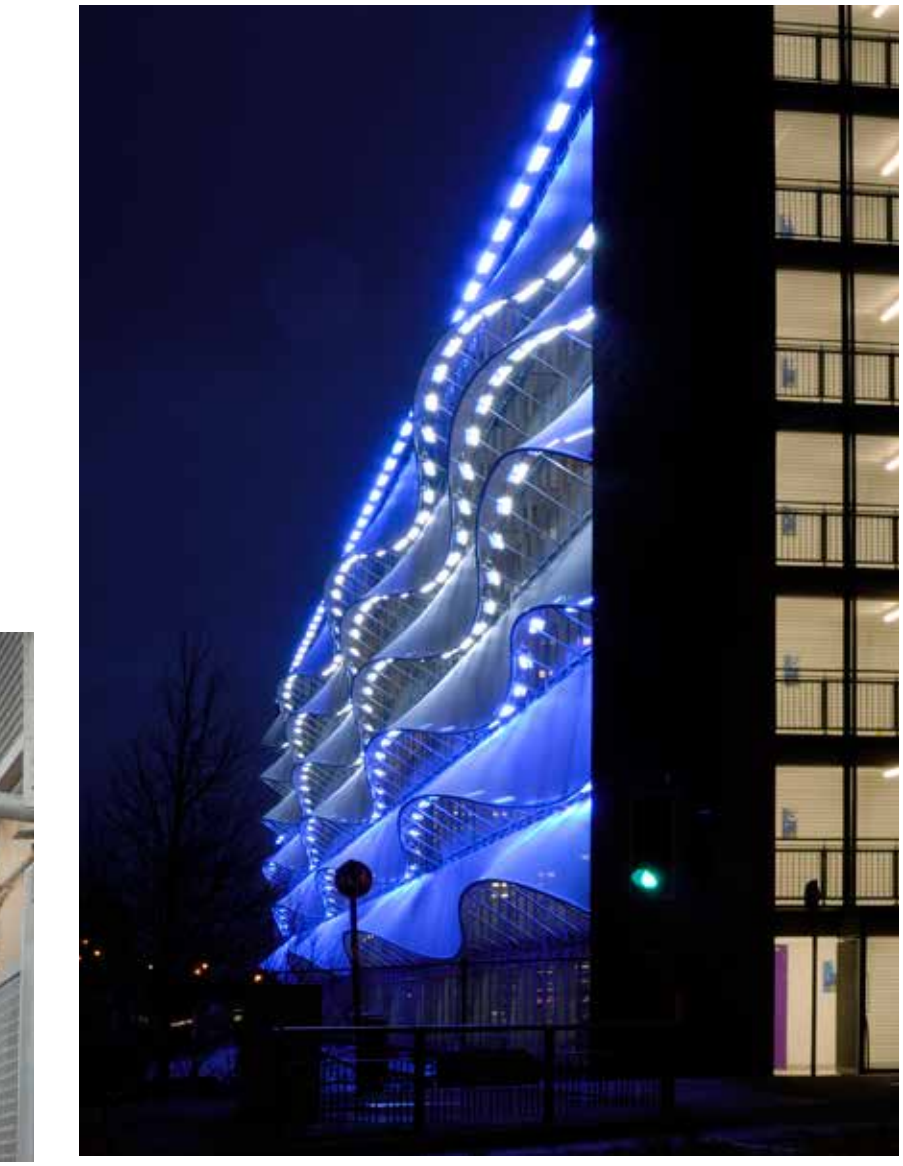
The mesh fabric is, by nature of being a mesh, translucent. It reflects the incident light at night with an almost internal glow, but also allows good levels of natural daylight to penetrate the parking areas during daylight hours. It even allows a "filtered" view out through the façade, as if through a lightly misted window ●

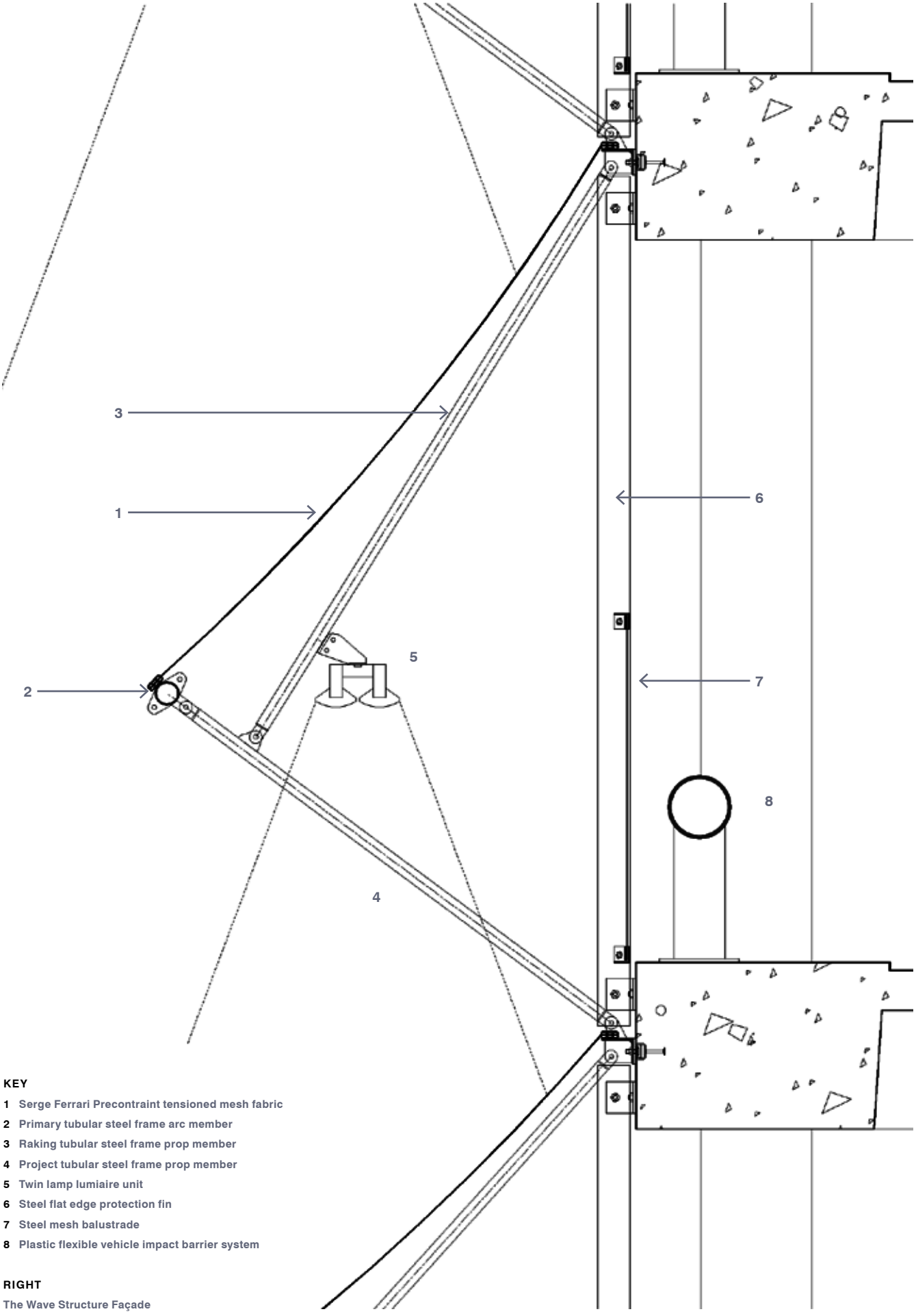
ABOVE AND RIGHT

Night time shot of The Wave Structure

BELOW

The Wave Structure in construction phase





KEY

1 Serge Ferrari Precontraint tensioned mesh fabric
2 Primary tubular steel frame arc member
3 Raking tubular steel frame prop member
4 Project tubular steel frame prop member
5 Twin lamp lumiaire unit
6 Steel flat edge protection fin
7 Steel mesh balustrade
8 Plastic flexible vehicle impact barrier system

RIGHT

The Wave Structure Façade

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