

Singapore  
**Profile**

Arup Newsletter | Issue 1 2013

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**ARUP**



Russell Cole, Office Leader

### Technology is nothing...

We're well past the mid-year point of 2013 and the National Stadium, with its dome roof steelwork complete, will open in under a year (facing page).

Impressive progress over a short time scale.

Only through harnessing the latest technological tools can we realise our designs with

ever increasing efficiency and productivity. Interestingly, the late Steve Jobs said, "Technology is nothing. What's important is that you have a faith in people, that they're basically good and smart, and if you give them tools, they'll do wonderful things with them."

I can't agree more.

Arup invests a lot of energy and money in staying at the cutting edge (see *innovation stories: pages 10 to 16*), but this would not be possible without a firm culture that celebrates people who are different. The numerous award and project wins we've had (see *stories: pages 9, 17 & 18*) bear testament of our people who constantly push the boundaries to find new answers to today's challenges.

Winning the 'Green Engineer of the Year' title this year has been a personal highlight, for which I am honoured and appreciative of the many well-wishes. More so, it is a recognition that passive design can create comfortable spaces with minimal impact on the environment (see *Schools built smarter: pages 6 to 8 and Green is the new black, Singapore Profile Issue 2 2012*).

Friends and peers often come up to me and exclaim they love what we do. I'm proud to share some of these smart stories in this issue, and I hope you enjoy reading them.

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Feel free to drop us a note on what you have enjoyed about the Singapore Profile. We welcome any thoughts on how we can make this a more informative read for you.

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Cover: Nestled within a lush tropical landscape, University Town (UTown) exemplifies the National University of Singapore's holistic and integrated approach to a sustainable campus. The precinct integrates sustainable design principles into its master plan, building design and operations. image © Darren Soh

# High point in new national stadium construction



© Arup | Clive Lewis

Arup scope: Sports venue design, civil, structural, fire and maritime engineering, geotechnics, acoustics, audio visual and multimedia, building physics and environmentally sustainable design, security and risk consulting, lighting design, advanced technology and research (moving structures); specialist technical services (sports lighting, bowl cooling, pedestrian modelling and turf consulting).



Above: Artist impression of the Sports Hub  
Below: Construction of the dome roof nearly complete.  
Image © Oaker and Arup

With just under a year to its opening in April 2014, it is symbolic that the final primary steel 'runway truss' of the new National Stadium's fixed roof was installed in July. A critical milestone in the \$1.33 billion, 35ha project, it marks the 70% completion point of the entire project and is a definitive step towards achieving the world's largest free-spanning dome, with a clear span of 310m. The 'runway trusses', which at their highest stand 77.5m above the pitch level of the stadium, form an important part of the framework of trusses that support the entire domed fixed roof and retractable roof.

The fixed roof, comprising 17,000 individual steel elements, weighs a total of 8,000 metric tonnes with a structural steel weight of just over 100kg/m<sup>2</sup>. In order to achieve this feat, a combination of advanced parametric modelling and in-house software was developed specifically for the project (see *story on page 15*).

To keep the bowl design as compact as possible and minimise the overall footprint of the stadium roof, we considered factors such as 340 different wind load cases for each of five different scenarios (moving roof open, closed, and in three intermediate positions), and even spectator visibility and comfort.

**Client:** Dragages  
**Design team:** Arup Associates + DP Architects + Aecom  
**Engineering:** Arup  
**Project dates:** 2006 – 2014

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# In demand and demanding

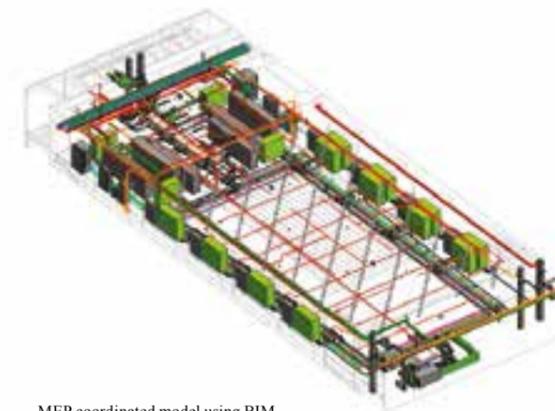
In an increasingly data-driven world, the rise of cloud computing, information streaming and real-time data analytics has led to a huge demand in data centres – especially in Singapore where increasing number of global operations headquarters are being based. This has inevitably led to a spike in energy demand to run entire floors of server racks while keeping critical IT equipment continuously within strict temperature and humidity conditions amidst a tropical climate.

Arup's leadership in the field is differentiated not just by our pioneering use of information and energy modelling in designing and engineering data centres, but also by our driving philosophy of sustainability.

## Top facts about data centres



Sources: National Environment Agency (September 2012). *Data Centre Energy Efficiency Benchmarking Final Report*. Arup, "Hungry giants", *A² Magazine Issue 9*.



MEP coordinated model using BIM

### Building Information Modelling (BIM) marries experience and efficiency

Just last year, Arup utilised BIM to design, construct and install a standalone cooling and power back up system for an existing Digital Realty data centre facility in Jurong East, Singapore. Based on our familiarity and understanding of the client's global standards and the landlord's existing systems, we leveraged 3D MEP Revit modelling to mitigate potential issues during construction, in a live environment.

We further proposed to our client to incorporate additional information into the 3D models, which would assist the data centre operations team meaningfully during the life of the facility. Such additional information includes the traditionally paper-based Operation and Maintenance Manual, as-built drawings, Service Operation Procedures and Emergency Operation Procedures. Suffice to say, the benefits of BIM certainly do not stop after the project is delivered.

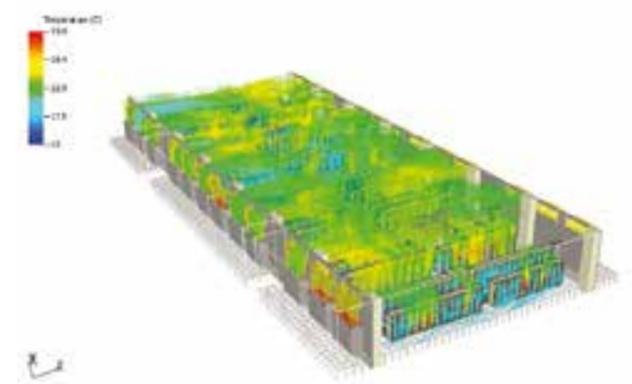
### Energy Modelling towards Green Mark certification

Energy modelling is a computerised simulation that provides an accurate and reliable representation of a building's performance including its energy consumption. With it, we study system interactions under various load conditions and operation scenarios to guide our design parameters, and optimise electrical consumption of the IT supporting infrastructure. With the launch of the *BCA-IDA Green Mark for New Data Centres* scheme that encourages data-centre owners to meet green-certification standards at the planning stage – even before their facilities are built, energy modelling is essential to predict PUE performance (Power Usage Efficiency).

We think it's high time too as it is estimated that the ten largest data centres in Singapore guzzle enough energy to power 130,000 households!

### Mission critical services:

Electrical engineering | Mechanical engineering | Hydraulic engineering | Fire services engineering | Fire engineering | Structural engineering | Security | Risk mitigation | Acoustics | Audio visual | Environmentally sustainable design | Energy modelling | CFD analysis | AutoCAD Revit 3D modelling | Site assessments | Feasibility studies | Due diligence | Detailed design | Power quality studies | Design and documentation | Design reviews | Cognition surveys | Construction supervision | Commissioning management | Capacity demand and analysis | Pre-project budget advice | Project management



Temperature stream lines for data suite

### Computational Fluid Dynamics (CFD) to follow the flow

In a data centre, where IT equipment is packed in tight configurations, it is critical to know if air is getting to the right places – and what kind of air, hot or cold.

Arup was tasked to determine if HSBC's Tseung Kwan O Data Centre in Hong Kong was operating efficiently; that its air conditioning system and various operating configurations were not allowing any equipment to overheat or exceed the IT equipment temperature limits.

Using CFD modelling, we analysed four existing computer equipment rooms (CERs) that contained both high and low density IT equipment. As the CERs were contained in a live data centre, access for model verification and result comparison was limited. Through the modelling alone, we were able to simulate the current airflow and match temperature profiles in the rooms; and identify areas where improvements could be made and the capacity for loads to be increased. This helped HSBC keep its IT operations resilient without any disturbance to its daily operations.

Everything from banking and cloud services to telecommunications and television is now driven by data, which must be processed in data centres. Such is the scale of growth of data processing that it has a significant impact on global energy consumption and carbon emissions. To design and build a data centre that is smarter and more energy efficient, Arup doesn't just rely on the impressive range of tools at our disposal. We can also draw from our extensive experience in the design of mission critical facilities and our array of multidisciplinary services from our team of engineers and specialists, using local, regional and global resources.

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## Schools built smarter

Education's challenges are always evolving. Soon, a new generation of net-native students will pass through the university system. These are the ones who will have grown up with smart phones, social media and virtual gaming. They will expect the university experience to reflect the real time, connected nature of the web, in a less wasteful and more environmentally conscious habitat.

As a result, higher education will have to become more flexible in order to respond to such changing needs. When it comes to the built learning environment, it is essential that facilities aren't just cost-effective to build, run and maintain – they must also be engaging, pleasant environments, equipped with quality systems that help institutions attract and retain students and staff.

### Bringing Nature Back to School

Arup is no stranger in the planning, design and engineering of such environments. In one of our larger scale projects for the National University of Singapore (NUS), Arup led the sustainable design of University Town (UTown), consisting of four Residential Colleges (RCs), UTown Residence, the Stephen Riady Centre and the Campus for Research Excellence and Technological Enterprise (CREATE). Further, we also worked on the Ventus facilities building and the NUS Cultural Hub.

UTown is an extension of NUS' Kent Ridge campus and comprises of an integrated residential, recreational and educational facility spread across a 19ha tree conservation area. It exemplifies NUS' holistic and integrated approach to a sustainable campus, emphasising strategies for energy and water efficiencies, material and waste management and environmental quality and protection.

In merging the built environment with nature, Arup employed innovative space design to achieve daylighting and natural ventilation in a relatively dense environment.

Façade systems were optimised to balance conflicting needs for natural daylighting and views against solar heat gain. Extensive greenery, thermally comfortable outdoor spaces and green materials were key components of the design.

We also sought to conserve the natural topography and hydrology, preserving the existing green buffer around the campus. A shaded, interconnected pedestrian network that connects the various buildings generates social and learning encounters between people, nature and technology – making it a sustainable pedagogical environment.

As far as visually striking highlights go, other than the developments within UTown, the Ventus facilities building showcases various ingenious green features as well – the main feature being a wind scoop which captures and funnels air into the rest of the building. This makes Ventus the first office building with naturally ventilated circulation and discussion spaces.

Images © Arup | Jenny Lie



Our efforts have been recognised with top Green Mark awards for the various buildings as well as for the entire cluster. By understanding purpose, performance and future use, we bring enduring value to educational environments.

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SMU City Campus – City Escape



To achieve the large inter-connected spaces desired, Arup's fire safety solutions enabled the normal open circulation stairs to be used as escape routes. According to fire safety regulations, these would typically have to be enclosed. In a Singapore first, a retractable roof over the courtyard serves as a smoke control strategy in lieu of specialised smoke control systems, saving considerable costs.

**Yale-NUS College – Passively Friendly**

Situated just adjacent to UTown, this campus features passive design strategies such as natural ventilation and shading. An eco-pond used for storm water catchment adds to the view and outdoor environment while doubling as a rainwater storage system for site irrigation.

**School of the Arts (SOTA) – A Sublime Performance**



To create a consistently intimate environment for its 708-seat concert hall, Arup designed an innovative, motorised choir stall, allowing the stage depth to be adjusted according to the size of a performance. As for fire safety, the unique patterned façade on the academic floors allows smoke to escape without the need for additional enclosed lobbies and mechanical systems.



**Arup University**  
Increasing Return on Intellectual Capital

While physical campuses are still essential in enabling face-to-face interaction and social development, there may be instances where accessibility takes precedence. Within Arup, for instance, we've established a platform that brings together the very best of our learnings, global ideas and practices. We call this virtual learning environment Arup University, and through it, staff can continuously upgrade their knowledge, even earning themselves a Masters Degree without any disruption to the job at hand. Naturally, Arup's personal interest and commitment to the pursuit of higher education carries through to more thoughtful implementation of schools and campuses.

# Engineered to triumph

Campuses aren't all we've designed to be smarter and greener. Our philosophy extends across diverse projects, from private homes to grand performance venues. Happily, Arup's efforts haven't just been getting nods from the environment – they've also been recognised by publications, peers and government bodies.



**CREATE named Laboratory of the Year**

On 19 February 2013, a panel of judges including the editors of R&D Magazine and Laboratory Design Newsletter named Campus for Research Excellence and Technological Enterprise (CREATE) the Laboratory of the Year. This annual international award distinguishes excellence in research laboratory design, planning, and construction. It is added to CREATE's Green Mark Platinum and The Emerson Cup awards.

**ArtScience Museum aces show**

The Marina Bay Sands ArtScience Museum also took home honours in two awards. On 27 March 2013, the project bagged the ACES' Design Excellence Award for its structurally stunning design and response to an extremely challenging form dictated by renowned architect Moshe Safdie. At the Building and Construction Authority (BCA) Awards at Resorts World Sentosa on 16 May 2013, it proved its mettle again, winning the BCA Design and Engineering Safety Excellence Award.



**Setting Green Mark high**

At the same BCA Awards, Arup took home a record-breaking 10 Green Mark awards – a sign of our commitment towards sustainable design solutions.



**National University of Singapore – Ventus**  
New Non-Residential Buildings  
Platinum award

**Tanjong Pagar Centre**  
New Non-Residential Buildings  
Platinum award

**Yale-NUS College**  
New Non-Residential Buildings  
Platinum award

**M Social Hotel**  
New Non-Residential Buildings  
Platinum award

**16B Leedon Park**  
Landed Houses, Platinum award

**Capitol Development (Retail/Hotel/Theatre)**  
New Non-Residential Buildings  
Gold Plus award

**Capitol Development (Residential)**  
New Residential Buildings  
Gold Plus award

**Victoria Theatre and Victoria Concert Hall**  
Existing Non-Residential Buildings  
Gold Plus award

**Marine Parade Condominium Development**  
New Residential Buildings  
Gold Plus award

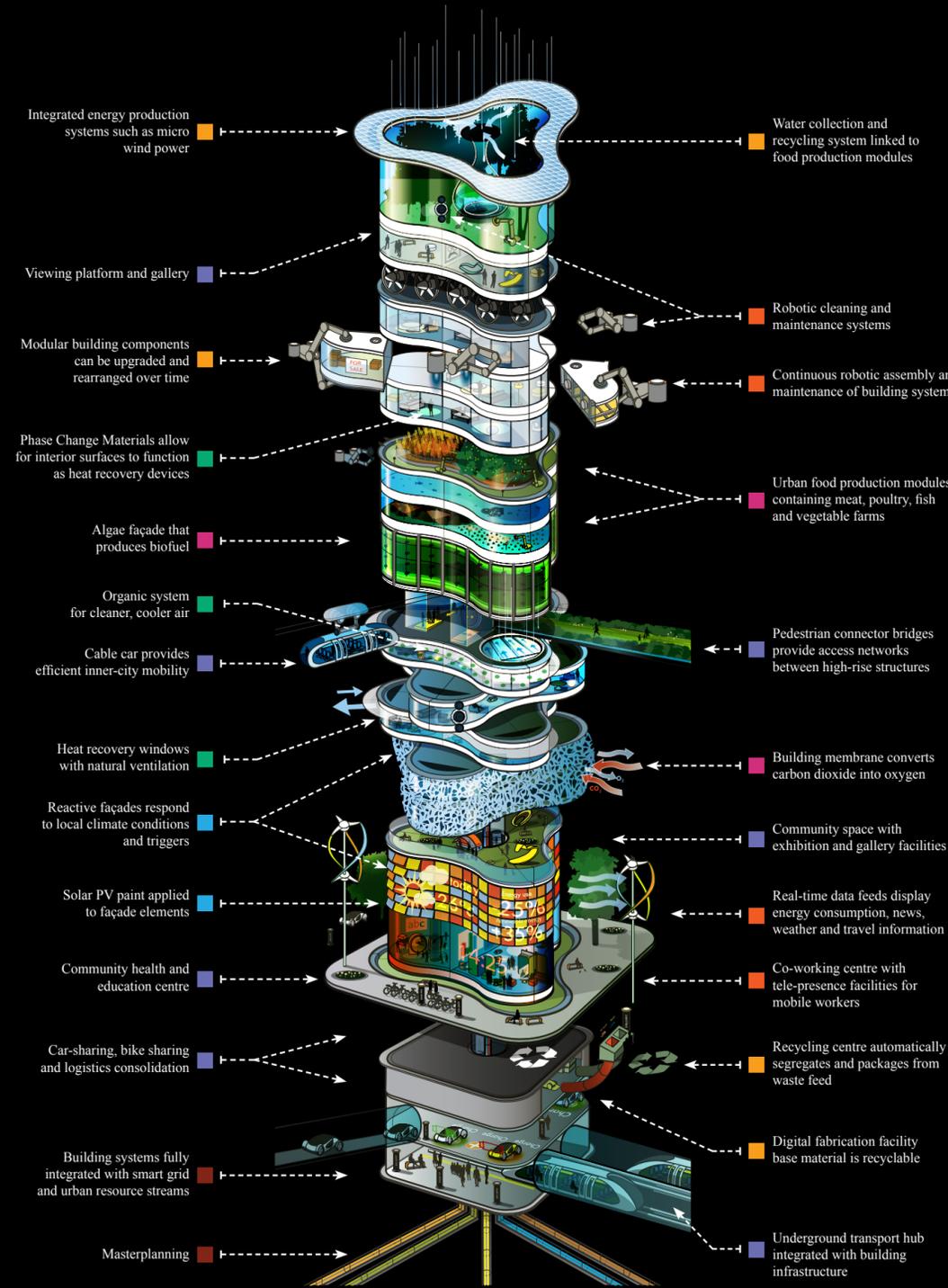
**BHP Biliton Marketing Asia Pte Ltd**  
Office Interiors, Platinum award

**Making new LEEDs**

Adding to the list of LEED accredited projects in a separate commendation this year: **BHP Biliton** (LEED Commercial Interior Gold) and **Tanjong Pagar Centre** (LEED Core and Shell Pre-certified Platinum).

# Tomorrow's cities

Illustration: Rob House  
Source: Arup Foresight & Innovation (January 2013), *It's Alive!*



By 2050, 75% of the human population – or 6.75 billion people which is almost the entire population of the world today – will be living in cities. What will these cities look like? How will they behave?

Between now and then, climate change, increasing scarcity of resources, rising energy costs, overcrowding and a preoccupation with preventing and minimising the effects of the next natural or man-made disaster will inevitably shape our vision of the built environment.

As city living takes centre stage, the design and function of urban structures and buildings will have to accommodate a generation of net-native adults who have lived all their lives engaging with smart devices and materials. They will expect everything to be interactive, living within a true 'Internet of Things' where the environment exists as an integrated smart system and can be manipulated in real time, catering to public needs while providing tailored experiences for the individual. Appliances will be networked and cars will probably be electric-powered and automated, changing power delivery implementations and transport and navigation systems.

This leads us to consider the physical infrastructure. Where will all the wood, steel, concrete and other materials for the creation of the world we dream of come from? While we are headed for a resource-constrained world, human ingenuity has always found alternative solutions to move forward. As new buildings replace the old, can a building's value take into account the potential of reusing and recycling the materials it contains? Even today, the role of demolition companies are changing – instead of being paid to remove waste, they're buying the privilege of taking materials away to resell them.

\* The cards on the following pages can be detached and used for ideas generation, or as thought provoking postcards embellishing your pin board.

- LEGEND**
- Resource efficiency
  - Technology
  - Productive building
  - Connectivity
  - Environmental control
  - Smart façade
  - Masterplanning



Connectivity

**Accessibility in tall buildings**  
Can buildings connect in mid-air?



Environmental control

**Organic systems**  
How ecological is your building?



Connectivity

**Dense train network**  
How close can the next train be?



Resource efficiency

**Clean water**  
Can rainwater be recycled?



Smart façade

**Reactive façades**  
Can your building façade respond to local climate conditions and triggers?



Resource efficiency

**Recycling demolition waste**  
Where does your refuse go?



Technology

**Real-time data feeds**  
How do we measure our impact on the environment?



Masterplanning

**Livable cities**  
How can we ensure responsible and sustainable growth in cities?



Connectivity

**Community spaces**  
How will we destress?



Productive building

**Modular plantation**  
How can we create more green spaces?



Productive building

**Sky terraces**  
What are the benefits?



Environmental control

**Occupant comfort**  
Can your building respond to microclimatic conditions to deliver optimum comfort?

## Downtown Line Bugis Interchange

Downtown Line Bugis interchange will be an important connection to Singapore's new downtown and the developments taking place within the Marina Bay. The new interchange will interface with the existing station, which meant that our consultants had to overcome the challenges of deep tunneling – in an area lined with historic shophouses. Arup designed an alignment that was 20m shallower than the initial base design and managed to pull off a 45m-long tunnel directly beneath the existing Bugis station while exposing its base slab. As Singapore's MRT network continues to expand, more clever solutions will be needed to overcome physical and structural constraints – to fit in more train lines within a congested city.

**Key services provided:**  
Tunnel design, civil and structural engineering, geotechnics, mechanical, electrical and fire engineering, acoustics

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## Victoria Concert Hall and Victoria Theatre

This Victorian-era landmark has nearly 150 years of history, and was gazetted as a national monument in 1992. To retain the historical gems within the building and in the quest towards sustainability, the chair backing will be recycled to create a feature wall at the foyer and chair stanchions will be a component of the new railings. This not only helps to reduce waste, but also contributes to social sustainability through retaining precious memories of the past that the public can relate to.

**Key services provided:**  
Acoustics, theatre consulting, fire engineering, environmentally sustainable design (ESD)

ARUP

## Singapore Sports Hub

Through a dynamic range of programmes integrating sports, leisure and the community, the Singapore Sports Hub creates a vibrant destination that is relevant to both the elite and general sporting community. Its well-connected strategic location and 24-hour accessibility every day of the year provides a sustainable platform for colourful Singaporean lifestyles and communities to flourish.

**Key services provided:**  
Sports venue design, civil, structural, fire and, maritime engineering, geotechnics, acoustics, audio visual and multimedia, building physics and environmentally sustainable design, security and risk consulting, lighting design, advanced technology and research (moving structures); specialist technical services (sports lighting, bowl cooling, pedestrian modelling and turf consulting).

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## South Beach

The central feature of South Beach is the striking canopy that spans over the entire development. Parametric modelling enabled numerous iterations of the canopy design which resulted in the engineering of a distinctive feature that responds effectively to local conditions. Its unique undulating form helps to capture natural wind, blocks solar heat gain, enables thermal buoyancy flows, admits daylight and reduces rain ingress. This passive design strategy allows modification of the space below and enables year-round occupation.

**Key services provided:**  
Civil, structural and façade engineering, environmentally sustainable design (ESD)

ARUP

## CapitaGreen

CapitaGreen breaks away from the conventional office building design and seeks to reintroduce lush greenery to Singapore's CBD. This is articulated through the use of extensive sky gardens on three levels and Sky Forest on the roof, which forms part of a unique air circulatory system that Arup designed. Installed with a wind scoop, the air circulatory system, much like that of a living plant's, draws cool air from the sky forest where tropical trees are planted. The air is then delivered through the 'Inner Tube', an empty central core, to each floor. Overall energy consumption is significantly lowered as a result.

**Key services provided:**  
Vertical transportation, environmentally sustainable design (ESD), acoustics, façade engineering

ARUP

## Gardens by the Bay, Bay South

Set at the water edge of Singapore's Marina Bay, the mega park features two cooled conservatories, more than 2,000 plant species from nearly every continent and 18 Supertrees, which are vertical gardens of up to 50m tall. To mitigate the greenhouse effect, high-performance and low-emissivity glass was used for their massive façades. Using the right type of glass means the stunning dome conservatories let light in but keep heat out. To protect the plants and combat very bright days, there is a light-sensitive shading system, with sails that unfurl from the steel arches of the structure and are completely hidden when not in use.

**Key services provided:**  
Façade and fire engineering

ARUP

## Bandar Malaysia

Spanning across 196ha and located approximately 3.5km away from Kuala Lumpur City Centre, Bandar Malaysia is envisioned to combine a vibrant mixed-use community with a commercial district to foster creativity and innovation. Arup partnered Broadway Malyan and delivered a winning concept that will make Bandar Malaysia the benchmark for sustainability and livability in the region. We provided key infrastructure and sustainability advice for this prominent project set to achieve the national vision of making Kuala Lumpur the world's top 20 most liveable cities by 2020.

**Key services provided:**  
Sustainable infrastructure design, civil and water engineering, site development, sustainable consultancy

ARUP

## South Beach

This 150,000m<sup>2</sup> eco-quarter designed by Foster + Partners is an exemplary showcase of green architecture. An exciting green feature is the extensive sky gardens which like the innovative canopy, act as 'lungs' to create greater natural air movement. Extensive greenery integrated into the development includes landscaping at canopy, sky gardens and residential balconies. These pioneering features will significantly minimise the urban heat island impact associated with densely built up environments. In land-scarce Singapore, the sky gardens also provide an accessible space for people to commune and take in Singapore's magnificent skyline.

**Key services provided:**  
Civil, structural and façade engineering, environmentally sustainable design (ESD)

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## Marina Bay Sands, Sands SkyPark

The 38m-wide and 340m-long Sands SkyPark is the world's largest cantilevered observation deck, and has become a symbolic icon for Singapore. Measuring as long as four-and-a-half Airbus A380s lined up one after the other, the SkyPark includes facilities such as landscaped gardens, signature restaurants, an infinity pool, and a 66.5m cantilevered viewing platform, offering visitors a 360° view of the city. This also makes it the longest connecting bridge that spans across the three 55-storey towers that reacts dynamically to strong winds and vibration of people movement.

**Key services provided:**  
Civil, structural, geotechnics, traffic, façade and fire engineering, acoustics and audio visual, security and risk, building modelling (3D)

ARUP

## Yale-NUS College

Yale-NUS will be the first liberal arts college in the island-nation and one of the few in Asia that integrates learning and living on a residential campus. Arup has driven the building massing of this development and introduced various strategies that target water efficiency, a key concern for Singapore. One such feature is the eco-pond that acts as a stormwater catchment and storage system for irrigation. It also encourages biodiversity and creates an aesthetic outdoor environment. This feature will create cost savings of approximately 75% on water expenditure – a great example of harnessing energy from nature.

**Key services provided:**  
Environmental, acoustics, theatre and audio visual consultancy, façade and water engineering IT and communication systems

ARUP

## Office Realtime

Office Realtime is a data visualisation tool that uses active data to guide sustainability-related behaviour change. It brings about sustainability awareness by measuring any number of sustainability indicators from computer usage, energy and water consumption to office copying and printing rates. Developed by Arup's Sustainability and Digital Innovation teams, the tool is the culmination of two years of Arup research. The implementation of Office Realtime has shown measurable positive impacts on office resource use and associated sustainable behaviours in areas such as travel-related carbon, cumulative paper use and energy consumption.

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## Pocket Habitat

Pocket Habitat is the only modular planting pocket actively designed to promote biodiversity on new or existing spaces. Each module pocket is a stand-alone unit containing recycled substrates and tropical plants – even vegetables for that matter. Its easy installation and flexibility to be moved when required will potentially reduce material and energy resources. In Singapore, Arup supports Verditecture who has launched the first habitat at the HortPark along Alexandra Road.

**Key services provided:**  
Design consultancy

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## 05 | Cool Stuff You Didn't Know Arup Does

# Crafting the future

While future scenarios make for interesting predictions, a good futurist considers the tools we will have at our disposal to help us achieve such futures in a realistic amount of time. Even when considering just one structure – Antoni Gaudi's Sagrada Familia, for example – an unparalleled vision in 1883, it was expected to take a few hundred years to complete. Fortunately, CAD technology and CNC milling have replaced manual design and hand carving, and the church can now be completed by 2026.

Today, we have an array of tools that helps us better predict – and then bring the future to life. Shapes that used to be too complex to calculate and almost impossible to construct can now be broken down into modular building blocks or warped beyond what was previously technically possible. Here are just some of the technologies Arup employs to shape the future – and build a futuristic present.

### Parametric Modelling



As architects and designers grow increasingly bold in their designs, such thinking and advances in digital surface modeling have made these new designs more difficult to engineer and construct. The lack of control over the geometry, in relation to both structural analysis and construction, in some cases proves to be a hurdle in realising a design.

Parametric modeling is a design technique that uses smart, three-dimensional modelling software to help create patterns, spaces and forms through the input of specific criteria and operational parameters. Arup's expertise in parametric has seen the development of in-house script that is customisable to specific projects. This bridges the gaps between the architecture, structural engineering, construction, facade engineering and building services, making the workflow between software more interoperable.

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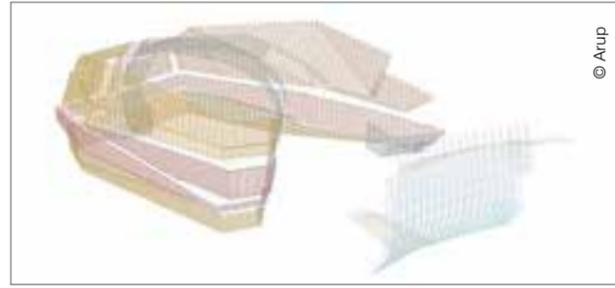
- LEGEND**
- Resource efficiency
  - Technology
  - Productive building
  - Connectivity
  - Environmental control
  - Smart façade
  - Masterplanning

**Optimising The Star's complex geometry**



The Star is vivacious in its design and boasts complex façade geometry with slanted columns. Made up of different geometrical surfaces - from flat to double-curved surfaces, meant that the extensive façade panels had to be rationalised and modulated for accuracy of fabrication.

As the initial model provided by the architect was a solid geometric model, a more buildable one would be necessary in order to overcome the complex design challenges in a timely and cost efficient manner.



Arup used parametric tools such as Grasshopper and Rhino to generate the modulations, and ensure full optimisation and constructability of each panel. Similarly, the development of the underlying structural steel support underwent the same rigorous design process. These models were then exported to structural analysis softwares – Strand and GSA, using a live link which allowed the entire design process to be more efficient and dynamic. The use of parametric modelling was especially useful in extracting detailed information which helped accelerate the fabrication process.

**Geographic Information Systems (GIS)**

No building, now or in the future, is going to be built on limbo. It will exist in an environment that's already shared by the built and natural world, present with its many quirks and complexities. Here, GIS technology helps Arup visualise, manage, analyse and collate data based on any location. From predicting floods and assessing environmental impact to planning business logistics and evaluating prospective nuclear plant sites, GIS solutions make it simpler and quicker to identify opportunities, reduce risk and adapt to better face the future.

**Thomson Line: a first in Singapore for a project of this scale**

Arup was appointed by Singapore's Land Transport Authority (LTA) to provide design and construction consultancy for two out of five design packages for Thomson Line – Singapore's sixth Mass Rapid Transit (MRT) line that will double the country's mass rapid transport network by 2020. Thomson Line will connect Marina Bay through the central business district to the northern tip of Singapore. The first package awarded to Arup includes three stations. The second package includes six stations.

With GIS, Arup had at our disposal tools for interacting with data using its real-world locations. The result is a visual and interactive representation of the Thomson Line project that provides instant accessibility to the



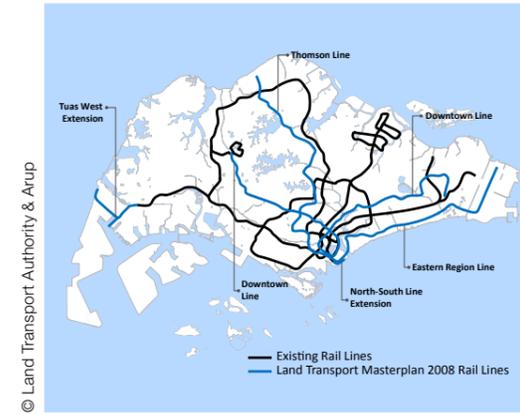
multidisciplinary project team via a secure web portal. Different access levels were granted across the project, allowing key decision-makers to retrieve relevant information, while confidential data remains hidden from low-level users, ensuring client confidentiality where necessary. This replaces the arduous process of searching for multiple documents and records for key pieces of information. Once linked into the database, information is available at the click of a button. Any data collected in the field can be instantly uploaded from any smart phone or similar device, allowing instant access to all users. Incidentally, the Thomson Line project is part of the Singapore office's initiative to consolidate all digital records and past projects into a single resource.

**Project wins**

**Eastern Region Line (ERL)**

We continue our success on previous high-profile projects such as the Downtown Line and Thomson Line with a new consultancy package from Singapore's Land Transport Authority (LTA) for the Eastern Region Line (ERL). Fully underground, the 21km-long ERL, comprising of 12 stations, will begin from Marina Bay, through residential estates of Tanjong Rhu, Marine Parade, Siglap, Bedok South and Upper East Coast, and linked to Changi in the east. It will also connect to the future Thomson Line. Arup's contract includes four stations and 4.9km of twin-running tunnels. The project is expected to be completed by 2020.

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© Land Transport Authority & Arup



**Singapore General Community Hospital (SGH) Campus**

The Singapore Ministry of Health have also awarded Arup the contract for the new Singapore General Hospital (SGH) Campus, specifically a 100,000m<sup>2</sup> mixed-use development at the community hospital site, next to the new National Heart Centre Singapore. We will be providing civil and structural engineering consultancy (design and traffic impact assessment) for a new 500-bed hospital, supporting operation facilities and barrier-free linkages to existing SGH tunnels and future campus facilities.

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**Bandar Malaysia Masterplan**

In Kuala Lumpur, Arup will provide key infrastructure and sustainability advice for the Bandar Malaysia Masterplan, turning one of the last historic sites within the city into an exciting international destination that will showcase Malaysia's culture and the arts. Spanning 196ha and located just 3.5km away from Kuala Lumpur City Centre, the former site of the international airport will be turned into a mixed-use community with commercial inclinations, fostering creativity and innovation. Arup partnered Broadway Malyan to come up with the winning proposal that captured the essence of master developer 1Malaysia Development Berhad's (1MDB) vision.

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© Broadway Malyan

# Award wins

## Young Consulting Engineers of the Year

At the Association of Consulting Engineers Singapore's (ACES) annual awards dinner on 27 March 2013, Arup took home two out of the three inaugural awards. Mak Swee Chiang was recognised as Young Consulting Structural Engineer of the Year for his outstanding project delivery on high profile projects such as the Singapore Flyer, Singapore Sports Hub and The Pinnacle at Sentosa. Vivien Foo's leadership in the design and construction aspects of the Singapore Sports Hub won her Young Consulting Female Engineer of the Year.



(From left to right) Young Consulting Engineers of the year: David Tan (Meinhardt), Vivien Foo (Arup), ACES Vice-President, Ling Shiang Yun and Mak Swee Chiang (Arup).

# Events

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## Florence lights up the night

June 2013

Florence Lam, Arup's global lighting leader, and the first woman to win the coveted Lighting Designer of the Year Award at the UK's Lighting Design Awards, was in town for a cosy client evening hosted in the Singapore office. Entitled 'Manipulating Light', Florence explored the complex relationship between lighting, space and architecture by sharing first-hand experiences on globally renowned projects such as the London Aquatic Centre for the 2012 Olympic and Paralympic Games. Guests enjoyed a relaxed and casual session as they sipped from tall, glowing glasses personally crafted by the lighting team.



## Green Engineer of the Year

Singapore Office Leader, Russell Cole received the prestigious award at the Building and Construction Authority (BCA) awards dinner at Resorts World Sentosa on 16 May 2013. He was recognised for his efforts to pioneer and promote an environmentally responsible approach to building design within Singapore. Many of his projects such as The Star, NUS UTown and the National Library building have received BCA Green Mark Platinum and Gold Plus ratings.



Russell (left) receiving the award from the Minister of Trade and Industry, Lee Yi Shyan.

## Arup drives creative thinking at UK Innovation Forum

June 2013

Jointly organised by The British High Commission and British Council, this two-day event showcased the UK's strength in innovation, design and technology in an effort to develop lasting partnerships with Singapore and Southeast Asia. In a congenial and robust plenary discussion, a panel of four, including Arup representative Stuart Candy, shared concepts and personal anecdotes that encouraged disruptive thinking as a means to stimulate creativity. About 120 policymakers, academics and business professionals were at the forum.



## Arup receives Eco-Office award

Sustainability is at the heart of our work at Arup and naturally, this extends to our office environment. Our continued commitment to promote the principles and practices of office environmental responsibility has earned us the Eco-Office Label\* from the Singapore Environment Council. Some of these green initiatives include switching off lights during lunchtime, provision of reusable cutlery sets to staff, use of biodegradable food packaging at office events, and consistent promotional efforts to encourage recycling of waste.

We were also honoured to receive the Best Eco Practices Award (with Merit) at the Eco Action Award 2013 in July. The awards were held in conjunction with Eco Action Day, an annual energy-saving campaign organised by Ricoh Asia Pacific in partnership with Singapore Environment Council, National Environment Agency (NEA), Energy Market Authority (EMA), National Climate Change Secretariat (NCCS) and Building and Construction Authority (BCA).

\* The Eco-Office Label is valid for two years (2012 to 2014).



# Acquisitions

## Artec Consultants Inc.

In February 2013, Arup formally integrated the staff of Artec into its acoustics, audio visual and theatre consulting team. Prior to this, Arup and Artec have been working together to provide specialist services for over 40 years. **Raj Patel, Americas Arts and Culture Business Leader** says, "Our expanded team offers clients around the world unrivalled knowledge, experience, skills, and cutting-edge tools to plan and design innovative venues for the 21<sup>st</sup> century and beyond."

## Strategic Economics Consulting Group (SECG)

In Australia, Arup acquired small but influential economics consulting group SECG. **Christopher Graham, COO Australasia Region** says, "I look forward to the positive influence they will have in broadening the range of services we provide to clients, as well as increasing the opportunities for our existing services in this region."



**Andrew Henry**  
Buildings Group

Singapore Buildings Group Leader, Andrew is no stranger to the world of large complicated projects. A Professional Engineer with nearly 20 years of experience in the design and construction of

steel and concrete framed buildings, railway stations and rail infrastructure, Andrew specialises in leading large multidisciplinary design teams on projects that require a high level of design integration and coordination.

Prior to Singapore, Andrew has worked in Sydney, Melbourne, London and Kuala Lumpur. His impressive local track record includes Singapore Sports Hub, Downtown Line 3 (MRT) and Singapore Flyer. Overseas highlights include the Albion Riverside Development in London and Kuala Lumpur's Petronas Twin Towers.

Andrew's ability to manage complicated projects is matched only by his zeal in building relationships, "I value trusting and understanding relationships with the people I work with, and this always delivers positive outcomes for the project and the team."

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**Brendon Mills**  
Water and Waste Management

Early this year, Brendon took over the reins from Daniel Lambert, who has assumed the role of Australasia's Water and Waste Management Leader and is now based in Sydney.

Brendon has a proven track record in the project and design management, planning and construction of water and infrastructure civil works. This includes urban water and irrigation transmission and distribution systems, waste water treatment works, hydroelectric power schemes and water sensitive design.

His work experience has brought him to diverse places such as Chile, UK, UAE, Qatar, Australia, Malaysia, Indonesia and Sri Lanka.

Brendon has recently been involved in providing infrastructure engineering services for the Damansara township in Kuala Lumpur, Malaysia. Arup's scope includes advice on utility requirements, transport planning, traffic engineering and sustainable water strategies.

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# The Penguin Pool



The series takes its name from Arup's first project in 1935 – the Penguin Pool at the London Zoo. Each event is as quirky and stimulating as the spiraling, cleverly cantilevered double ramps of the famed penguin enclosures. Held globally, the event sums up everything Arup believes in: the sharing of ideas across a diverse spectrum of people, the celebration of creativity, and the perpetual drive to excellence.

Singapore's second edition of the Penguin Pool held in October 2012, won our office, alongside Shanghai and San Francisco's, the inaugural Golden Penguin award. The winners were judged on their effectiveness in building a network of creative contacts and improving Arup's influence in the design world. To read more about Singapore's Penguin Pool series, check out our last issue, *Issue 2/2012*.

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**World leaders in design, engineering and business consultancy**

Established in Singapore since 1968, Arup has over 11,000 planners, designers, engineers and consultants spanning 90 offices in 38 countries. The firm's creative spark is derived from the beliefs and convictions of the firm's founder, the engineer and philosopher Ove Arup. Recognised for creating some of the world's most iconic projects like the Sydney Opera House and the Beijing National Stadium, Arup's impressive portfolio of Singapore projects include Marina Bay Sands®, Singapore Flyer, The Helix, School of the Arts, South Beach, Gardens by the Bay, Singapore Sports Hub, Capitol Development, Downtown Line 3 and Thomson Line. Our success is founded on delivering Arup's global expertise locally and we now have over 350 staff offering a range of specialist disciplines unparalleled in Singapore.

**Singapore services**

Acoustics | Audio Visual and Multimedia | Building Information Modelling | Building Physics | Civil and Structural Engineering  
Environmentally Sustainable Design | Façade Engineering | Fire Engineering | Geotechnics | Geographic Information Systems  
Green Mark & LEED® Consulting | Infrastructure Design | Infrastructure Masterplan | Rail Systems | IT and Communications Systems  
Lighting Design | Maritime Engineering | Mechanical and Electrical Engineering | Program and Project Management | Security and Risk  
Consulting | Site Development | Sports Venue Design | Urban Design (Sustainability) | Theatre Consulting | Transport Planning  
Tunnel Design | Vertical Transportation Design | Water Engineering



