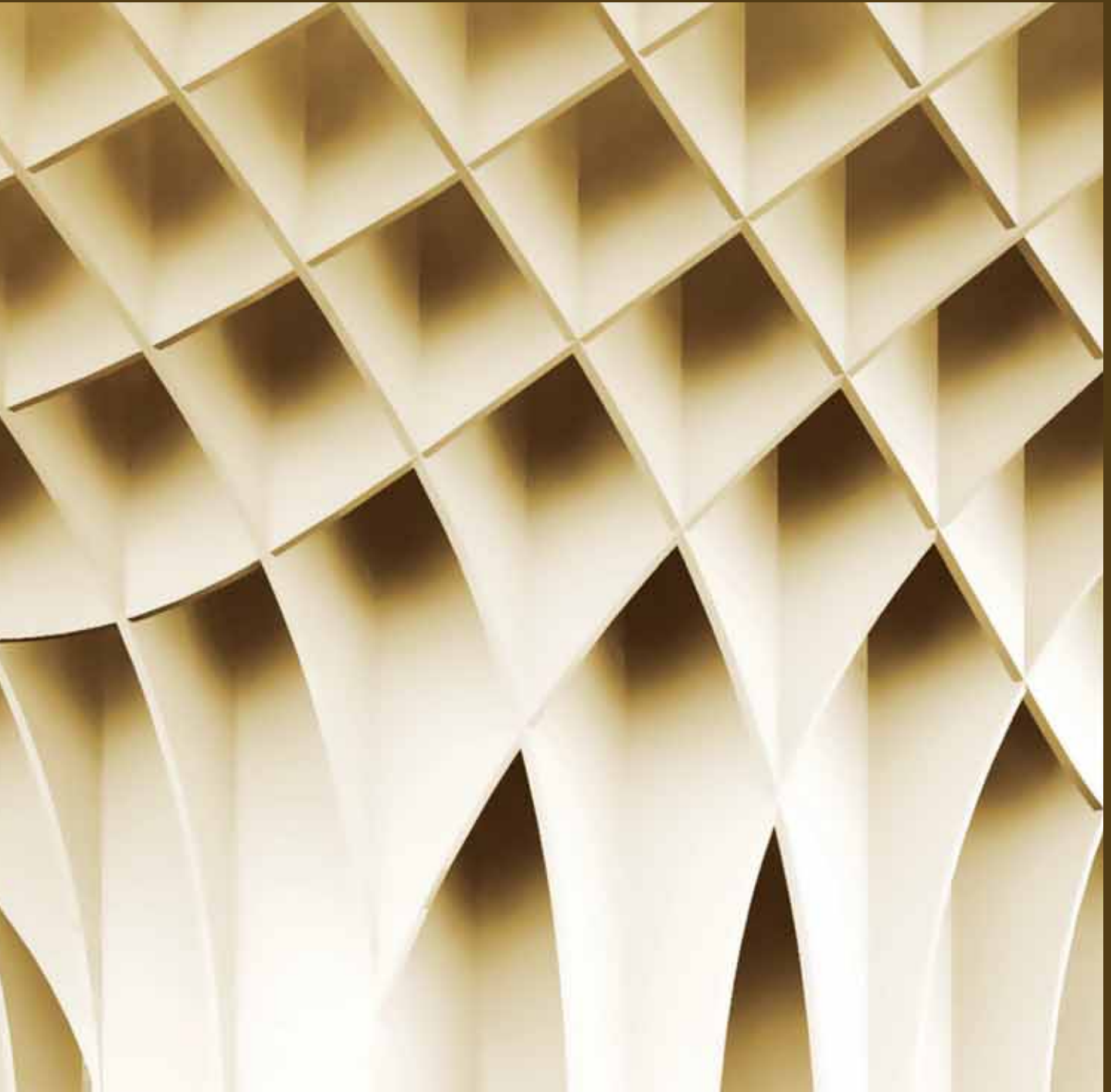


DESIGN YEARBOOK 2007

A glimpse into Arup's creative world

ARUP



WORKING WITH ARUP,
WE HAVE BEEN BACKED UP BY A
WEALTH OF EXPERIENCE
AND TECHNICAL EXPERTISE

Thought:

Where inspiration is concerned, the creativity of our people results in widely appealing, well-rounded work. Diversity, whether in discipline, geography or culture, is a characteristic expressed in every Arup project.

The strength of our relationships is fundamental to this – relationships between Arup and our clients, between project team members, and between Arup people.

The design and development of national infrastructures, whole towns, transport systems, individual buildings and the products that help to realise them are defined by the expression, response and innovation that takes place within these many-layered relationships.

The broad spectrum of disciplines that Arup offers worldwide amounts to a collective expertise that knits all of this together. The projects outlined in this book reveal the essential line of logic that threads through all of our work and helps to produce original, highly effective outcomes.

For us, inspiration flows from start to finish.

革新的な解
法が要求さ
れる魅力的
なプロジェ
クトの数々

Ryota Kidokoro, Tokyo

ARUP RECOGNISES THE SKILLS OF INDIVIDUALS AND
PROVIDES OPPORTUNITIES
FOR THEM TO EXCEL ALONG WITH THE COMPANY

FORWARD TO
SUBSTANTIALLY EXPANDING
OUR COLLABORATIVE ACTIVITIES
TO MUTUAL BENEFIT

Professor Lord Bhattacharya, University of Warwick

THE ARUP TEAM
SHARED OUR
PASSION

FOR THE PROJECT AND OUR

PRIDE

IN ITS TIMELY DELIVERY

Daniel Grollo, Grocon

THE REAL MAGIC OF WORKING FOR ARUP LIES, FOR ME, IN
OUR INTELLECTUALLY RIGOROUS, CREATIVE, HOLISTIC AND
MULTIDISCIPLINARY
APPROACH TO OUR WORK,

AND THE BUZZ OF PULLING TOGETHER SPECIALISTS IN DISPARATE FIELDS

Eli Konvitz, London

**ARUP HAS A TECHNICAL EXCELLENCE
THAT I REALLY ENJOY.
IT'S AN ENVIRONMENT THAT
FOSTERS CREATIVITY**

Neil McClelland, New York

4-D MODELLING ENABLES SIMPLE DIALOGUE
ABOUT THE MOST COMPLEX INTERFACES WITH

THE PEOPLE
WHO REALLY COUNT –
OUR CLIENTS

Rob Leslie-Carter, Sydney

**HERE AT ARUP THERE'S
FAITH IN ABILITY**

Leroy Le-Lacheur, Boston

在ARUP令人愉快的
的就是你有机会
接触很多令人兴
奋的项目,可以与
全世界不同国家
的同事分享经验

Dagang Guo, Shenzhen

ARUP'S SKILL
AND EXPERIENCE
LETS US MAKE THE MOST OF

**OUR SKILL
AND EXPERIENCE.
THEIR INTELLIGENT
APPROACH
MAKES SENSE,
AND MAKES LIFE
EASIER**

Mike Hartwell, AMEC

NAKATUTUWA ANG MAGING BAHAGI
NG ISANG ORGANISASYONG
NAKAPAGBIGAY NG MGA
MAKABULUHANG KONTRIBUSYON
SA BUONG MUNDO

Leslie Anne I. Lucero, Manila

04 Twisted thinking

Separating pedestrians from traffic has made a world of difference in Singapore

06 Going underground

A new type of ventilation system is installed in a New York subway

08 A vision for education

How technology is helping to reform Britain's schools

10 Travelling through time

An updated transport interchange is revitalising one of Sydney's biggest business districts

12 Istanbul's grand Canyon

A multi-faceted engineering and consultation venture is the first of its kind in Turkey

14 Air and earth

A segmented roof where each section can withstand the weight of four sumo wrestlers per m²

16 Working with heritage

The re-modelling of an ancient Chinese city

19 Shaken, not stirred

Building to withstand natural disaster

20 Drive cycles

A new software tool promises greater automotive efficiencies

22 Restoration with a mission

How one school has made a truly memorable performance of preservation

23 Taller, stronger, better

Working with the Chinese authorities has resulted in two tall buildings ideally suited to their environments

26 The new language of consultation

70 000 local residents have their say on the UK's M1 motorway widening project

28 The bridge of size

How cycling in the Netherlands is becoming a way of life for an entire community

30 Washing water

Efficient sewerage systems that will last for several lifetimes

34 Shades of Seville

A new landmark is a harmonious collaboration between imagination and science

36 Bright ideas

Arup's teams make light of The Boston Institute and Louis Vuitton stores worldwide

39 Improving outdoor comfort

With an increasing development in hotter countries, microclimates are multiplying

40 When words are not enough

Articulating the creative process is promoting a unified vision

42 A river runs through it

The new stadium design inspired by all things aquatic

43 Fast forward

The race is on to redevelop Stratford in time for the 2012 Olympics

46 The flame game

Prevention proves the perfect cure in fighting fire hazards

48 Young on the inside

Unilever House may be Grade II listed on the outside, but inside it's completely new

50 Plane and simple

Efficient planning at China's new airport is making travel easier on the environment

52 Bowled over

A facelift helps to maintain Melbourne Cricket Ground's iconic status

54 Moving forward

Effective development of infrastructure has a significant impact on economies

59 Inside the lives of buildings

How to plan a building for life

60 Building legacies

The extra dimension in planning sustainable buildings

62 Saving for a rainy day

Water shortages are running out thanks to rainwater harvesting

63 For the record

Cambridgeshire's new guided busway introduces a green dimension to public transport

64 Natural defence

How one defence force is using nature to its advantage

66 Finding a firm footing

Controlling landslides for safer surroundings

68 21st century alchemy

Why Treasure Island is a goldmine for its residents

69 In the driving seat

Investigating the biggest influencers for tomorrow's world

70 Climate culture

How our climates may inform the way we live tomorrow

Twisted thinking

Singapore's recent bridge development supports the idea that separation is, sometimes, for the best.

71 In response to an international design competition from Singapore's Urban Redevelopment Authority for a new bridge to take road and foot traffic over Marina Bay, Arup, architect Cox Group and Architects 61 submitted a proposal to separate pedestrians from road traffic – two bridges instead of one.

"It was a very engaging experience," explains Greg Killen, Arup's design manager for the project. "After being appointed as the competition winner, the team worked closely with the client to develop the idea of two bridges. Splitting the project into two parts allowed us to spend more of the budget on the pedestrian component. This offered design opportunities above and beyond a single multi-purpose bridge."

The average road bridge is made of concrete and follows a straight path. This makes design and construction simpler and reduces cost. However, such an approach – with a flat, straight path – is not as enjoyable an experience for its pedestrian users.

The vehicular route will cross the bay on a relatively simple piece of infrastructure, with the bulk of the budget being saved for a footbridge of an arresting design. The bridge will resemble the double helix structure of DNA. Unique, complex and challenging in engineering terms, this form will appear cool, elegant and very simple to its users.



"As we developed our thinking about a slim structure that would incorporate sun shading, we were drawn to a tubular form. The client was an active part of the design process and kept pushing us creatively, which was a very positive process," explains Greg. "This resulted in our design director suggesting the bridge's structure."

The structural form is essentially two coiled springs, one sitting inside the other and intersecting only at the bridge's deck. Each coil on its own will appear unstable to pedestrians passing through the helix – but the opposite is true. The unravelling forces are delicately balanced by a network of fine cables and struts that set up a series of checks and balances similar to the way the bases in DNA hold nucleotides in position to form the molecular structure.

All of the world's great bridges are, in their own way, unique, although most of them are variations on a particular structural system, for example, a suspension bridge. With neither truss nor beam, the double helix is fundamentally different.

Using powerful computer models, the structure of this complicated form is being created out of components that have been standardised into repetitive elements – reducing production and construction costs significantly. The ongoing maintenance will be greatly reduced by the use of duplex grade stainless steel, a relatively new alloy that is stronger than conventional stainless steel and more resistant to surface staining.

"Aside from being stronger alloys, duplex stainless steels are less prone to the staining that plagues conventional stainless steel used outdoors," explains Greg. "So the finish will be superb."

The bridges will open in 2009, linking the entertainment and arts and culture quarters of the city, which are currently being redeveloped. □



"Duplex stainless steels are less prone to staining, so the finish will be superb."

Greg Killen, Arup



Going underground

A new ventilation system will keep New York's 21st century subway system breathing easily.

➤ New York City is as much a sprawling metropolis below ground as it is above. Thousands of miles of tangled cabling, pipework, tunnels and subways battle for room, so building a new subway requires intelligent use of any available space.

The city's new 2nd Avenue subway line involves Arup as part of a joint venture to deliver conceptual, preliminary and final design engineering services for this US\$16BN mass transit project, extending 14km under Manhattan. Arup's expertise in tunnelling, geotechnics, structural design, pedestrian modelling, fire and mechanical, electrical and public health (MEP) have all been applied. Construction began in April 2007, and phase one of the project is scheduled to open in 2013, with a budget of US\$3.8BN.

As far as the mechanical discipline was concerned, the biggest challenge was to design and consult on a compact ventilation system for the subway. The other was to convince the Metropolitan Transportation

“Our ventilation design solution resulted in about US\$90M savings in construction, and a further US\$32M in capital and running costs on the entire line.”

Mohammad Tabarra, Arup

Authority (MTA) of its space and cost-saving advantages, particularly as an existing system had been tried and tested on other subway lines for years. Installing a single common fan-plant ventilation at each end of the 16 stations would serve both the tunnel and the station. This was opposed to the more costly and spacious twin plant system MTA was already using.

This bespoke ventilation solution was first suggested during the concept design stage in 2002 and was initially met with scepticism. Although single plant ventilation systems are used elsewhere in the world, the concept was new in New York City and a compelling case needed to be submitted to the MTA.

Through a series of presentations, Arup's team detailed all of the benefits of the new system, including making the fan units more accessible to personnel, allowing for easier maintenance and inspection, managing risk, and reducing maintenance costs. This was followed by a methodical explanation of all ventilation modes of operations that can occur in stations and tunnels (normal, congested, emergency), to ensure the design worked.

Once approval was given, a ventilation system was custom-designed and sized to suit the client. This

included the type of fan, fan plant layout, damper and duct configurations and a complete engineering analysis.

Extensive computer modelling techniques were used to simulate train movement inside the station and tunnel environments, including an examination of air temperatures and velocities. These were carried out for normal, congested and fire emergency situations to thoroughly ensure that all the components were up to the job.

During the preliminary engineering stage in 2004, all 16 stations were included in the design solution, which proposed routing all ventilation ducts to the same fan chamber. “Our design solution resulted in US\$32M savings in capital and running costs – US\$2M at each station,” reveals Mohammad Tabarra, Arup's lead tunnel ventilation engineer on the project. “We also saved 150m² of underground excavated space per station, which was worth a further US\$90M on the entire line.”

The single plant ventilation system was the largest value engineering item in the project's mechanical, electrical and public health (MEP) discipline. □

- Savings of 150m² underground excavated space (circa US\$5M) per station
 - Reduction in capital and life-cycle costs (circa US\$2M) per station
 - More accessible tunnel vent fan plants allowing easier inspection and repair
 - Design compliant with the latest health and safety standards
- Scope



Extensive computer modelling techniques were used to simulate air movement inside the station and tunnel environments.

“We don’t just want to put in some shiny new kit that gets used and then put aside – we want to help improve learning and teaching long-term.”

Rebecca Goldberg, Arup



A vision for education

An integrated, borough-wide ICT managed service will make Greenwich the envy of other UK local authorities.

➤ Improving and sustaining the academic achievements of pupils from some of the UK's most deprived communities is a top priority for Building Schools for the Future (BSF), a government programme with the aim of transforming England's secondary schools. Information and communication technology (ICT) supports this by offering individual learners the opportunity to learn when they want, where they want and in the style that best suits them.

In the past, private finance initiatives in the education sector have focused on capital expenditure projects such as buildings, with ICT often bolted on afterwards – and poor results as a consequence.

Recognising the potential for ICT as an academic enabler, the Department for Education and Skills has called for ICT to be built into the school environment 'from the building design stage onwards'. The other new opportunity presented by BSF is that a single ICT service is being procured across the entire education system of the London Borough of Greenwich, as opposed to individual contracts for each school or education entity.

"It means the contracts are big enough to entice some of the ICT players who have never been tempted into education before," explains Arup's Rebecca Goldberg. "As buyers with aggregated buying power, the schools are in a good position to keep quality and standards up while pushing the price per head down."

What is Building Schools for the Future?

Building Schools for the Future (BSF) is an ambitious national programme aiming to lift educational attainment in the UK over a 10 to 15-year period. New schools will be built and existing schools upgraded to meet the needs of communities in the 21st century.

The London Borough of Greenwich is one of four 'pathfinder' authorities, where the principles will be developed for a £45BN national investment programme.

Greenwich has appointed VT Education & Skills (VTES) as its strategic partner to deliver BSF.

Arup's role in supporting VTES through the BSF programme involves the creation of a shared vision for ICT across Greenwich, leading the specification and procurement of borough-wide systems and services. Arup is also acting as design programme manager for the building design of the new schools, which offers the opportunity for close integration of the ICT into new custom facilities.

This pooling of resources on a local level, together with more advanced ICT capabilities, also enables schools to become more specialised vocational learning centres. Students will travel between sites to fulfil their particular learning requirements, and their education and attendance will be tracked and supported using bespoke computer systems. And the function of schools will change, too. No longer will they focus solely on learning.

"We're looking more broadly at what can be offered on school sites, such as health and employment services, so the school starts to become more of a community hub," continues Rebecca. Understandably, stakeholder engagement is critical to the project's success.

"For this to work, we need to engage with the entire school community – the teachers, the pupils, the parents and the governors. We've devised a rigorous stakeholder engagement programme with workshops to explain our ideas and the potential benefits, and to gain input and feedback."

Being this thorough is fundamental if the new approach is going to succeed in implementation and bring about raised educational outcomes.

"This is just the start," says Rebecca. "We don't just want to put in some shiny new kit that gets used and then put aside – we want to help improve learning and teaching long-term." □



A complex upgrade of a busy interchange combines modern infrastructure with the appeal of history.

➤ A project to upgrade and expand Parramatta's Transport Interchange has reinvigorated Sydney's second largest business district. During extensive demolition, excavation and building work, the landmark Parramatta Railway Station remained operational, yet the project was opened a full 10 months ahead of schedule.

The Parramatta Transport Interchange has been the main avenue for passenger and freight services through western Sydney for nearly 150 years. Some of its architecture dates as far back as the origins of the New South Wales rail network itself. The nature of the precious buildings and subways that make up the interchange, including Parramatta Railway Station, meant that achieving the perfect balance between technical and historical integrity was vitally important.

Arup worked in joint venture with Hassell, the project architect, providing structural, civil, geotechnical, façade and acoustic design services, as well as vertical transportation design, transport planning, environmental risk and safety engineering, design verification and temporary works design.

Engineering work began in 2002. As lead engineer, Arup planned a series of construction phases to allow the station to remain open during commuter times. That work included designing bridges that could be installed over weekends – yet could support the trains passing over them just hours later. The western pedestrian concourse was expanded, doubling in width, to improve access to the station. It was put in place by building the two new rail bridges, passing

“The Arup team’s responsiveness to design content and our management processes really benefited the project.”

Tim Parker, general manager, Project Development,
Transport Infrastructure Development Corporation (TIDC)

beneath four railway lines, taking two days each to install. Platform extensions to the west end of the existing concourse increased the station capacity at rail level.

Designed for people

“The main aspect of the design remit was to consider issues such as buildability, but also commuter protection,” says Andrew Henry, Arup’s resident engineer for the project. The existing railway station was at maximum capacity, with frequent queuing and crowding. To rectify this situation, new lifts and escalators were installed, providing faster and safer access. “To improve pedestrian movement, we halved the number of supporting columns beneath the retained portion of the existing concourse by designing steel underpinning beams that were jacked into position,” adds Andrew.

Employing creative processes played a key part in designing the new interchange structures, as layers of construction history made for a unique situation at each stage of the project. For example, engineers

excavated through two ageing subways underneath the railway in order to construct new escalator voids. The new bridge foundations for the concourse had to be installed 1m lower than the existing foundations and be capable of supporting both the new and existing bridges.

Above ground

The main scope of the project above track level comprised two elements: the design and build of the platform, and the roof. As one of the most visually striking features of the development, the roof was prefabricated in sections next to the station, with roof sheeting, ceilings and even lighting pre-assembled so that it too could be installed in segments over weekends.

The futuristic-looking roof is made up of panels separated by skylights and voids. Designed with lightweight construction in mind, it affords generous shelter from wind and rain and extends over the bus interchange. □



Up on the roof

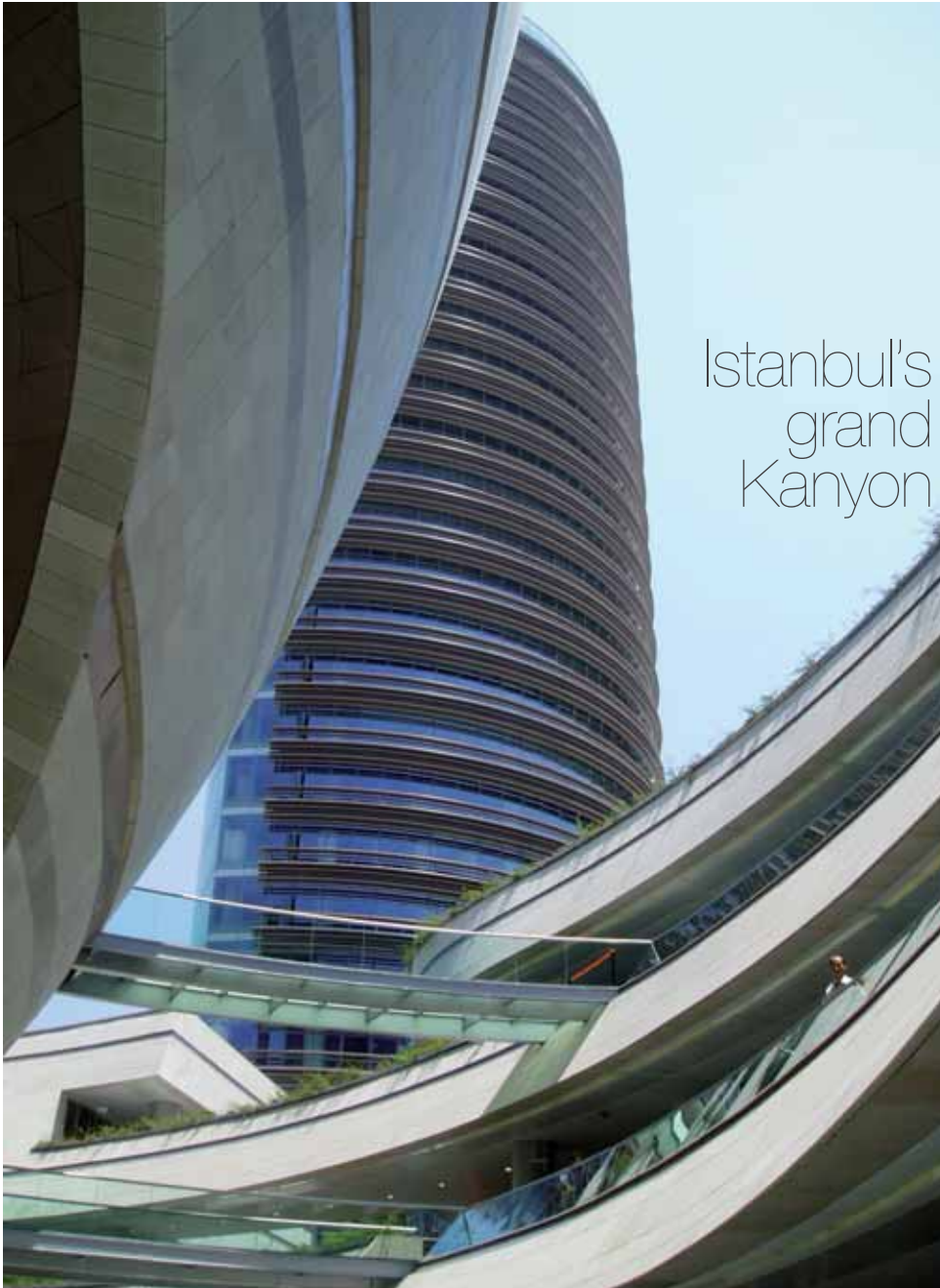
- The roof’s structure consists of rectangular parasols through which sunlight passes to warm waiting passengers (above).
- On two streets, delicate façades of glass louvres allow cooling breezes to pass through the station. They fuse internal and external spaces.

through time



The contemporary construction complements the existing historical buildings.

- Cost: A\$100M
 - Includes amenities for local buses and taxis
 - One of the busiest stations on the network
- Scope**



Istanbul's grand Kanyon

**Embracing
Turkey's history
while promoting
progress required
a combination of
imagination, skill
and experience.**



The development has multiple entrances at different levels, which knit the project to the city at various street locations and to the subway station.



- **Site area:** 30 000m²
- **Investors:** Eczacıbaşı İlaç A.Ş. & İş GYO A.Ş.
- **Prime agent:** Arup
- **Lead architect:** The Jerde Partnership International
- **Executive architect:** Tabanlıoğlu Mimarlık
- **Engineering design:** Arup

Scope

➤ Istanbul is the only city in the world to stand on two continents. It has been the capital of the Roman Empire, the Byzantine Empire, the Latin Empire and the Ottoman Empire. Eager to be known for more than just its history, developments such as the Istanbul Kanyon are helping Turkey to be recognised as contemporary, progressive and at the forefront of modern culture.

Opened in Spring 2006, the Kanyon complex is a multi-use development described as a city within a city, attracting brands such as Harvey Nichols, Bally and Wagamama to the country for the first time.

Architectural expertise on the project was provided by The Jerde Partnership and Tabanlıoğlu Mimarlık. Arup, the lead consultant on the project, employed teams from its offices in Turkey, America and the UK to project manage and engineer the venture. They took charge of the mechanical, electrical and structural aspects of the development. They also took responsibility for the civil, façades, acoustic, security, seismic, holistic and wind studies disciplines.

This multi-disciplinary approach was not only required to create the structure's distinctive silhouette on the skyline, sitting well with the minarets and domes that define the city's ancient heritage. It was also required to embrace the high-level technological approach that the development of the complex demanded.

Arranged as a series of 'districts', Kanyon includes retail space, apartments, entertainment facilities and a 27-storey office tower. It features sport facilities and links to a metro rail system. All of these are connected by an interior street, or 'canyon'.

Traversing the site, the bends of the canyon reflect the shape of the office tower above – a major presence in the city. Here, Arup's design team realised a continuous curved shape, including the entertainment sphere and retail terraces, to create a completely different kind of environment where people can walk along a sidewalk partially open to the elements. The four terraces of retail space extend the full length of the site and provide a podium for residences above.

A particular challenge facing the team was the entertainment centre, which houses the cinemas. It features a half-inverted sphere with a very small footprint from which the structure expands outwards, requiring an innovative engineering approach.

A full height triangulated tubular steel lattice frame was used as an external shell for maximum stiffness. Reinforced concrete walls were placed at the back of the sphere to balance and transfer down the big tension forces from the inverted semi-sphere system. Internally, two inverted L-shaped brace frames added lateral stiffness to the structure, the diagonals of which were arranged to fit around corridors and doorways inside the building.


Turkey's economy is thriving – growth rates of 8.9% and 7.4% in 2004 and 2005 are testament to that – and Istanbul Kanyon represents how Turkey is embracing the free market economy on an international level. It is a statement defining how the country wishes to be perceived in the 21st century. □

Air and earth

Rehearsing disaster has guaranteed centuries of solid performances from Suzu Performing Arts Center.

➤ The twin challenges of earthquakes and strong winds turned renowned architect Itsuko Hasegawa's vision of a 'floating cloud' roof for the new Suzu Performing Arts Center into a test of strength. Located in a small town, Ishikawa, next to the sea in Suzu City, the building's proximity to water, high winds and seismic geography meant that its construction had to be as enduring as the elements surrounding it. The roof was no exception.

Though the design remains elegant and imaginative, it is strong enough to support the equivalent of four sumo wrestlers for every square metre of its 3500m² span for extended periods. The threat of earthquakes added an extra dimension to the project.



Main image: The roof defines the aesthetics of the building, both outside and inside (inset).



Turning a vision into reality

Arup's solution was to create 26 miniature steel domes, ranging from 6m to 11m in diameter, arranged in a bubble pattern and supported by slender columns. Construction of the roof was accelerated by employing a set of standard sizes for the domes, which were then connected and strengthened with steel plates. Since domes are one of the most efficient structural forms for large spans, this resulted in a very efficient and lightweight roof structure, despite being required to support extremely heavy snow loads.

Stability was increased by connecting the roof to a concrete wall within the building, creating a 'super core' that increased resistance against lateral loads. This proved extremely effective when, in March 2007, an earthquake measuring 6.9 on the Richter scale hit the area. The building escaped with zero structural damage. "The building survived without a scratch," says Arup structural engineer, Ryota Kidokoro. "Successful results from a full seismic test." □

Budget of US\$15M

- The building serves as a multi-purpose community centre for Suzu city
- Optimal balance between aesthetics, structural integrity and cost

Scope





Working with heritage

Tangye in Jinan is arguably the birthplace of Chinese civilisation. A unique sustainability masterplan works with the natural landscape and reveals the heritage of the site.





This region's cultural heritage and famous springs are being respectfully incorporated into the new plan for the area (centre).



Jinan, the capital of China's Shandong province, is located in the southern lower reaches of the Yellow River. It lies on a plain surrounded by mountainous country, where the Beijing-Shanghai and Qingdao-Jinan railways meet. Two areas, located in the east and west, have been earmarked for the expansion of Jinan city, each accommodating a population of around a million.

Tangye lies in the Eastern Development Zone and, like its parent city Jinan, has an ancient heritage. Iron was produced around here several centuries BC, peaking again later during the Tang Dynasty (618–906 AD). Under Emperor Li Shimin, the village became a centre for weapons manufacturing – hence the name Tangye (*Tang' from the dynasty, 'Ye' referring to metalwork).

Arup was commissioned by Shanghai Industry and Investment Corporation (SIIC) to review the 1800ha control plan and produce a sustainability masterplan to include mixed-use development for a 150ha area within Tangye and the road network from an earlier control plan.

A better way of life

The response to SIIC's brief was wide-ranging, covering many aspects of the development including recommendations for a sustainable design approach that will positively affect the lives of present and future residents. Working closely with SIIC, Arup established several key objectives to guide the creation of a sustainable design solution. »



“The creation of city parks would significantly raise land values.”

Tom Armour, Arup

This focused on working with the natural landscape, protecting and revealing the archaeological heritage and protecting historic communities.

Jinan, known as the ‘city of springs’, has 72 famous springs – but ironically the whole area is struggling to keep up with water demand.

Arup saw a case for reverting to old technology to solve the problem, proposing to abandon the original control plan proposal to culvert the dry river valleys. The sustainable alternative was to terrace them to capture water and begin the process of restoring the denuded landscape. The river valley proposal opened up the potential to create linear public parkland, providing uninterrupted safe transport corridors for pedestrians and cyclists. The parks are also planned to connect the wider natural landscape to provide ecological corridors, linking into the Weizi mountain to the east, which will be reforested as part of the new habitat for indigenous wildlife.

“The creation of the city parks would significantly raise land values, while also reducing the cost of flood storage,” says Arup project landscape architect Tom Armour.

New housing will, in part, be placed among the existing houses, retaining the street layout of the historic villages. Workplaces and schools will be placed all around Tangye New Town, so that the distances to travel are moderate and encourage walking and cycling. A public transport system running around the town will mean only a short walk to the transport service for every resident.

Proposals for the provision of utilities will lead to savings in water use, energy and goods distribution and, above all, the cultural heritage will be preserved. All around the town, cultural sites are retained and embellished, forming an historic ‘iron trail’ for residents and tourists to enjoy.

Tangye New Town is a prime example of using a unified and multi-disciplinary approach to integrate the need for development with the site’s history and the natural environment. □

Environmental solutions

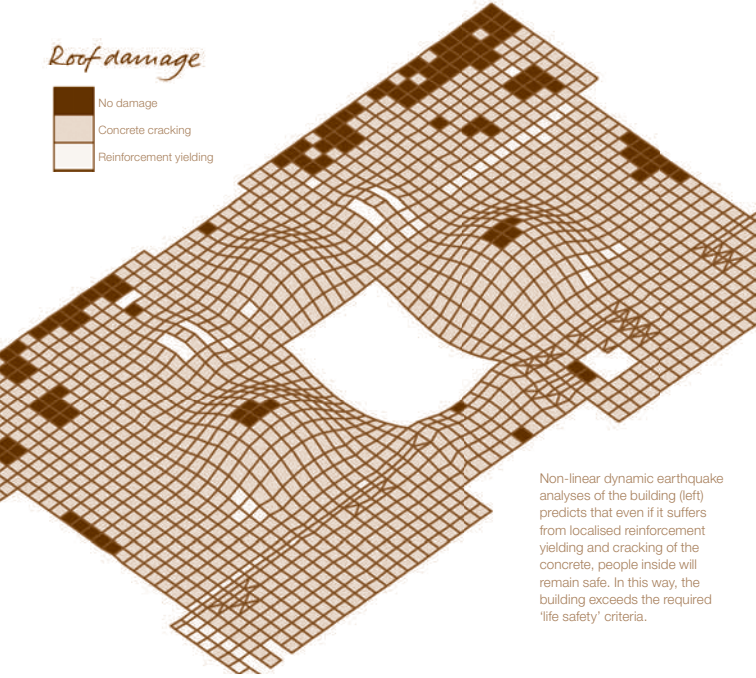
Arup’s proposals included:

- Segregating demand for drinking water and grey water, with the latter being recycled locally. The capacity of the water treatment plant is being reduced by 63%, with almost 2ha of land saved.
- Providing multiple sources of energy, including clean local micro-generation schemes.
- Rebuilding biodiversity through the linear city parks and the Weizi mountain reforestation.
- Respecting the heritage of Tangye, making it a place where people want to live and creating an unforeseen value stream as a tourist attraction.



The environmentally-sensitive, people-oriented approach adds value for the population while providing practical solutions to real problems.

Roof damage



Non-linear dynamic earthquake analyses of the building (left) predicts that even if it suffers from localised reinforcement yielding and cracking of the concrete, people inside will remain safe. In this way, the building exceeds the required 'life safety' criteria.



Other innovations at CAS

With the project's advanced carbon reduction features, the intention is to achieve a platinum LEED® (Leadership in Energy and Environmental Design) accreditation.

- 1 The undulating grass-covered roof provides natural insulation.
- 2 Rainwater is harvested for use within the building.
- 3 Solar power generates electricity and heats water.
- 4 Natural light and ventilation systems save money.
- 5 Renewable materials have been used where possible during the construction.



Shaken, not stirred

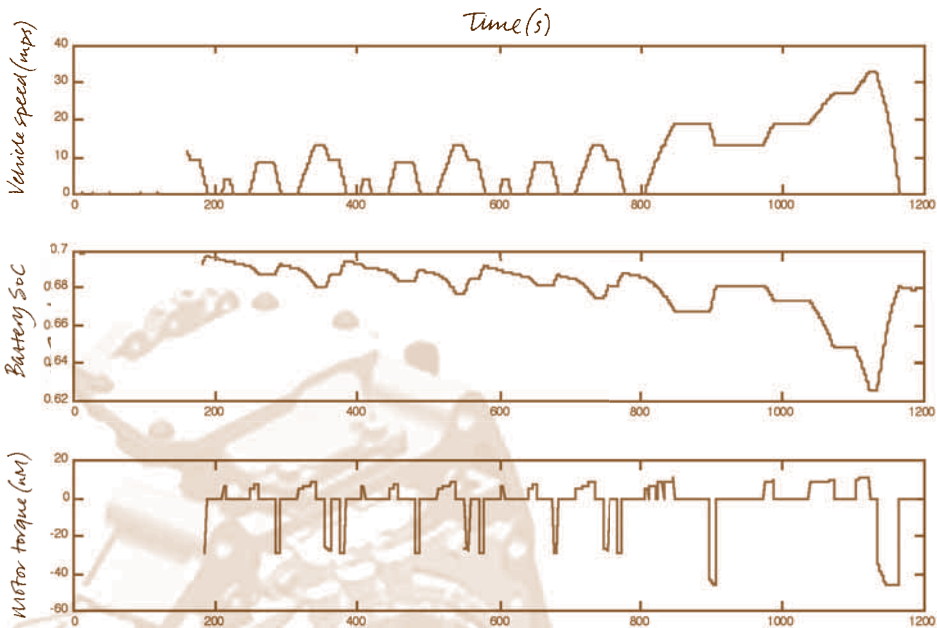
➤ Founded in 1853, the California Academy of Sciences (CAS) was moved to San Francisco's Golden Gate Park after its original home was destroyed during the 1906 earthquake that devastated the city. Eighty three years later it suffered again, when the 1989 Loma Pieta earthquake damaged much of its structure, resulting in its closure.

CAS's new home, still in Golden Gate Park, had to be earthquake resistant. But being a non-profit organisation meant that designing to code by using conventional 'land anchors' – strong foundations that help to hold the building in place – was going to be prohibitively expensive. As other innovative concepts such as advanced energy and cost-saving features were already being used, the team decided to find an alternative to the traditional methods of minimising earthquake dangers.

The answer was almost the complete opposite of a land anchor. Rather than try to hold the building rigidly in its place to ride the earthquake out, as is the convention, the CAS building is designed to move with the earthquake. This amount of 'give' reduces the forces that enter the structure, thereby improving the overall performance of the building.

The approach saved US\$1.5M. Advanced computer modelling made the concept so compelling that the appropriate authorities gave construction the go-ahead. □





How is it measured?

At best, a gasoline or diesel engine has a typical maximum efficiency of 35%, usually at about 55 mph (88kph) in fifth gear. But the constant stop/start, acceleration and deceleration takes a car out of its optimum efficiency zone most of the time. With vehicle efficiency increasingly calculated by grams of carbon dioxide emissions per kilometre, drive cycles are essential in understanding the relative efficiency of any one vehicle.

WARPSTAR can compare vehicle speed (top), battery state of charge (middle) and motor torque (bottom) over time to assess vehicle efficiency.

Drive cycles

➤ A recent partnership between Arup and WMG – the global innovation specialist based at the University of Warwick – has yielded revolutionary software for modelling vehicle efficiencies.

Named WARPSTAR (Warwick Powertrain Simulation Tool for Architectures), the tool will be used to design more environmentally friendly vehicles. It does this by evaluating their energy usage over a given 'drive cycle'. For example, many cars are not as efficient over inner city cycles that require a lot of accelerating and decelerating, as opposed to long motorway drives.

WARPSTAR's development has been directed by Arup's

20 years of experience in the design of sustainable road vehicles. The tool has already been widely adopted for the creation of components for hybrid cars and there are plans to extend its capabilities still further. It now takes into consideration issues arising from introducing a hybrid vehicle into the existing infrastructure.

Arup's Robin Haycock says: "If we wanted to look at the most efficient form of public transport around London's Oxford Street, for example, we could use WARPSTAR to devise and analyse a unique drive cycle for that route. Then, by inputting the vehicle's mass, rolling resistance and drag for each mode of transport,

we can find out how much energy will be consumed. Using this data, combined with our other planning tools and specialist capability within transport planning, we have an effective methodology to provide direction in sustainable mobility."

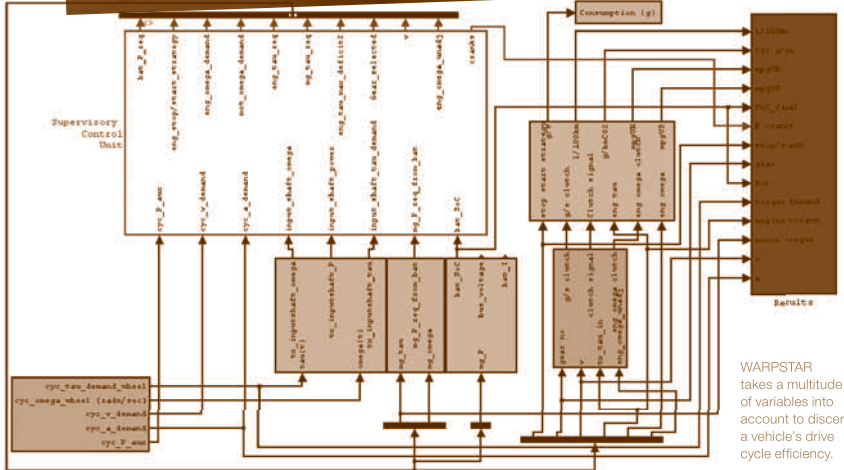
All of this also has broader implications and benefits for the industry – particularly when working with planners to specify low energy usage vehicles while continuing to meet market demands for sustainable mobility in future urban developments.

WARPSTAR has holistic thinking at its heart and will benefit both the design of new vehicles and the planning of transport networks throughout the UK's towns and cities. □

"Arup allows its relationships with academia to grow beyond shared research and discovery."

Jeremy Watson, Arup

Working with academics, Arup's tools have aided in the development of hybrid vehicles.



WARPSTAR takes a multitude of variables into account to discern a vehicle's drive cycle efficiency.

Meeting the Kyoto agreement

Kyoto requires a 20% reduction in CO₂ emissions by 2020, which means we will have to find ways to make smaller and lighter cars more attractive to buy.

A hybrid car

104 g/km CO₂*

A small city car

113 g/km CO₂*

A 4x4 off-road vehicle

350 g/km CO₂*

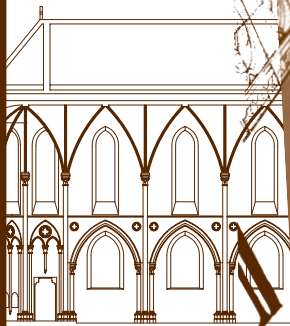
A performance sports car

450+ g/km CO₂*

* (g/km CO₂ = grams of CO₂ emissions per kilometre)

"Arup and WMG have complementary skills, and we already work together on several projects. I look forward to substantially expanding our collaborative activities to mutual benefit."

Professor Lord Bhattacharyya, director, WMG, University of Warwick



➤ Located on a Hong Kong hillside and built in 1875 in early French Gothic style, Bethanie was a sanatorium for the Mission Étrangères de Paris for almost a hundred years. Between 1997 and 2003 its future was uncertain until the Legislative Council approved capital works funds for its restoration, along with two adjacent cowsheds, to make a new film and TV school for the Academy for Performing Arts. To retain and preserve as many of the heritage features as possible, the Academy spent time tracking down missing original features and materials.



"The Bethanie Conversion Project was a highly complicated one which called for the most enthusiastic, engaged and dedicated team to see it through in a meticulous manner."

Philip Liao and Partners Ltd

Restoration with a mission

During the investigations, it was discovered that in the 1950s a flat roof had replaced a pitched one over the main body of the sanatorium. With the brief agreed to reinstate the pitched roof, Arup – working with architect Philip Liao and Partners Ltd – took things further and designed a glazed solution. This results in a light and airy interior with a skylight roof. From the outside the roof closely resembles a traditional slate roof, maintaining the original style while using state-of-the-art materials and technology. □



Cow sheds were converted into a 150-seat auditorium (above) while the heritage of the structure was treated with utmost respect. The glazed pitch roof has a dramatic impact on the space within, and negates the need for artificial lighting during the day (left).



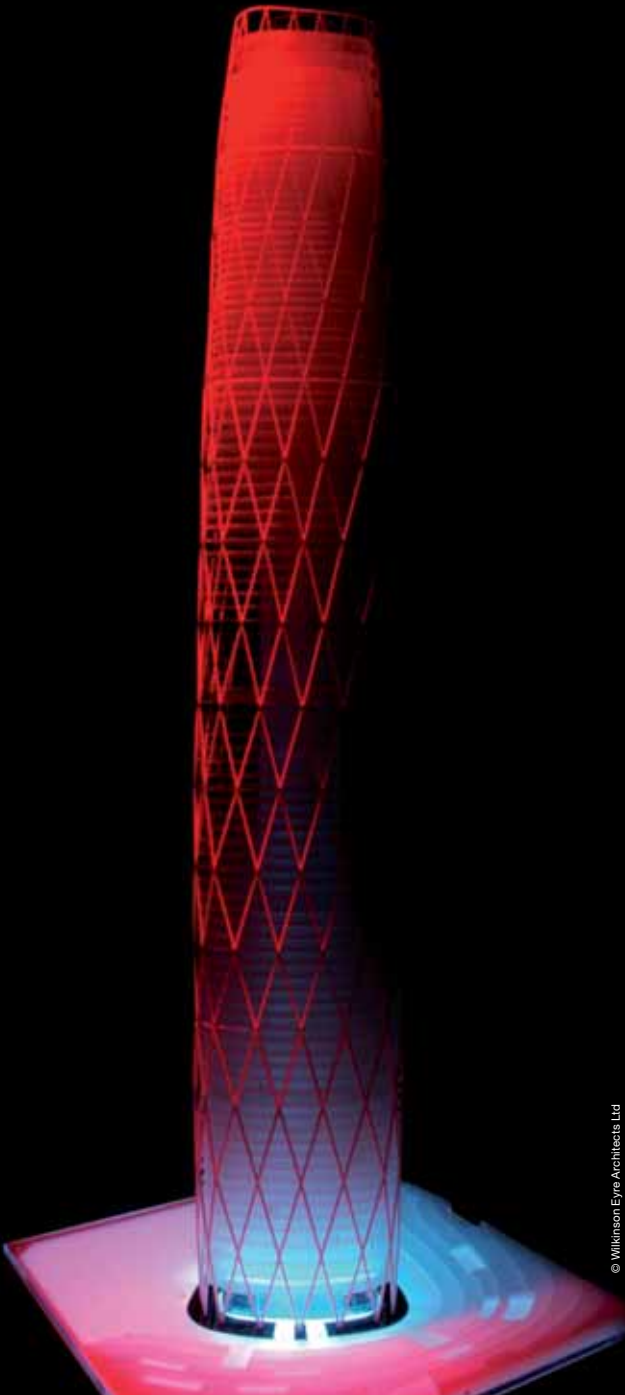
© Wilkinson Eyre Architects Ltd

Taller, stronger, better

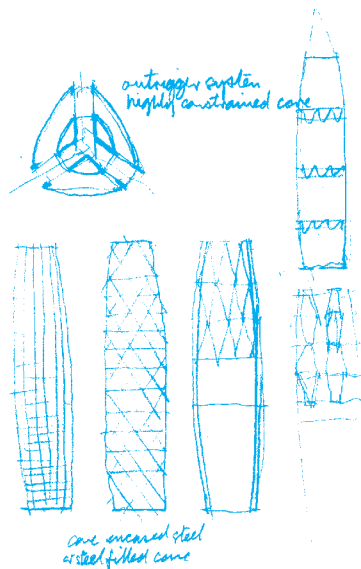
As China's buildings grow ever taller, the region's varied geography and strict building regulations require a fresh approach to modern problems.

➤ With inner city land at a premium, one of the ways that China's construction industry can keep pace with the demands of its expanding economy is to build towards the sky. And while the market demands taller buildings, China's geographical diversity presents developers with a range of challenges, some of which have resulted in stringent building codes. For example, any structure over 200m will normally require the formal review and approval of an expert panel appointed by the government.

By applying international best practice, Arup has recently been instrumental in helping construction works within the building codes for two of China's tallest structures: the 432m Guangzhou West Tower or GWT (pictured, left) in the Southern China region, and the 330m China World Trade Center (CWTC) in Beijing. »



© Wilkinson Eyre Architects Ltd



➤ Arup engineer Craig Gibbons describes the challenge of building the GWT in the typhoon climate of China's south coast: "We were developing a 103-storey building which means the lateral loads that have to be resisted are quite significant. Because the design also calls for a six-star hotel at the top, the codes are even stricter. It's thought that in a relaxed environment hotel guests are more aware of the lateral acceleration of the building and so the building needs a really stiff structure."

The design of the GWT – a joint venture between Arup and architect Wilkinson Eyre – employs a diagrid steel frame that vastly reduces that amount of steel needed in the structure. Arup had to submit detailed plans to the local authorities to explain how it would support both the weight of its floors and the lateral forces of typhoons and earthquakes on it.

Extensive computer analysis was used to find the optimum geometry for the diagonals as well as the floor layout in relation to the curve of the building elevation and profile. An efficient, cost effective composite structure based on concrete-filled steel tubes around a concrete reinforced core was proposed to ensure the building was ductile, but did not drift too fast. The same concrete core helped allay evacuation concerns by providing a hardened fire escape route. This was particularly important for the GWT, where lifts have an evacuation mode to express-shuttle people to the ground floor. »

Left: Arup's engineers experimented with varying shapes and structures to find the one that most suited the local geographical constraints.



Ductility

The ductility of a building refers to its ability to tolerate deformation caused by movement. Good ductile materials such as high strength steel can elongate by 20% before failure. When a building weighs hundreds of thousands of tonnes, the cost of that much steel can be prohibitive. Composite solutions, including concrete and steel, balance cost and structural concerns.

Unshaken

The CWTC is located in Beijing, which is a highly seismic region, and the risk of earthquakes was the biggest concern for the authorities.

“With a tall building in a high seismic area you try to use less concrete, which can’t tolerate a lot of movement, and more steel which is more ductile with a higher shear resistance,” says Arup engineer Joey Tsui. “But a pure steel building would be too soft and can flex too much, so we have to strike a balance. The building can’t be too stiff and it can’t be too soft.”

Arup suggested using a shear wall made of composite steel plate – the first of its kind in China – stretching from the basement levels up to the 16th floor. This, along with composite columns and steel beams and braces throughout the entire structure, formed the core of the building. A perimeter of more composite columns and beams added further robustness, but it was the application of the bracing that called for even more ingenuity.

It is standard practice to use concentric braced steel frames when constructing a building of this kind, with a square or rectangle braced from one corner to another. But Arup’s Goman Ho says that it is not ideal. “Concentric bracing can resist very heavy lateral loads, but it also draws in a lot of force into the beam column joints which is not good for seismic areas. So for each wall, we included one bay with an eccentric brace that doesn’t join to its opposite corner, to reduce the potential damage to the building.”

Furthermore, to satisfy the experts’ performance criteria entirely, a 1:30 scale physical model was used in laboratory conditions, where seismic waves were simulated through a ‘shaking table test’ (pictured, above right) to justify the nonlinear time history analysis carried out by Arup. The test showed that this analysis is sufficient to simulate the structures under various levels of earthquakes, and that the CWTC will not be damaged by a level 1 earthquake, will be repairable after a level 2 earthquake and will not collapse under a level 3 earthquake. □



Left: The shaking table test. Above: The core structure. From the third level basement to the 16th storey, a unique steel plate shear wall was employed.

“A pure steel building can flex too much, so we have to strike a balance.”

Joey Tsui, Arup

The new language of consultation

Widening a motorway can have a massive impact on local people, and with tens of thousands affected by such major works, monitoring concerns is vital.

➤ The M1 carries more than 100 000 vehicles a day and is one of the UK's busiest motorways. When the government gave the green light for the widening of a large section of the motorway between junctions 21 and 30, the Highways Agency called on Arup to carry out a feasibility study, preliminary highway and structures design, traffic modelling, environmental assessment and the hugely important local consultation process.

Taking the £3BN project through the statutory public consultation and managing thousands of responses generated during the exercise wasn't going to be a straightforward task – particularly considering the 50-mile (80km) stretch of motorway in question crosses three counties and dozens of parish and district councils. A stakeholder matrix, prepared by Arup, identified 260 statutory consultee groups and showed that residents of around 70 000 properties along the motorway corridor had to be engaged in the consultation. The task of communicating with so many people and logging their response was formidable, and the volume of data generated was expected to be vast.

Visual mapping

To meet the huge logistical challenge, Arup developed a series of bespoke tools. These included a consultation database to store resident comments, and a software package used at public exhibitions to provide rapid access to scheme drawings. These were then displayed on large monitors.

"As we had over 100 scheme drawings, we asked people to tap in their postcode and the correct plan for their area opened up," explains Xavier Woodward, Arup's project communications manager. "We also showed aerial views and could zoom in on individual houses, which people found fascinating – and we had engineers on hand to explain what the plans meant."

Key features

- 5000 responses to questionnaires received
- 80 000 leaflets distributed
- 8 consultation exhibitions held in 2006

This interactive tool brought clarity to an unfamiliar technical subject and, as very little land was to be taken, residents were reassured to see for themselves that their properties were not affected by compulsory purchase.

GIS database

Around 5000 people responded to a questionnaire, which was available online or in hard copy, and the consultation database had a GIS facility which mapped the responses geographically, showing precisely where they were clustered along the motorway route. The responses could additionally be viewed according to the key issues being raised.

The consultation database was a vital tool in managing the massive volume of information being generated. Questionnaire responses could be analysed quantitatively as soon as they were received and the system provided a clear audit trail for data tracking.

Eight exhibitions with around 2000 visitors were held in an eight-week period in 2006, and printed material was also distributed for those who were unable to attend.

The present system is the result of Arup's innovation, and a set of tools with 'bolt-ons' is being developed for future consultation management. "A generic template would generate cost efficiencies, a major benefit for both us and our clients," concludes Xavier. □



"The use of technology to allow focused viewing was a real success, and there were many complimentary comments."

Ian Scholey,
director, Major Projects (National),
Highways Agency



Local residents responded warmly to the way the consultation was handled:

"The Highways Agency should be congratulated on the standard of communication they are adopting – well done."

Resident, Chellaston

"I found the booklet and displays excellent. The photomontages made understanding 'levels' and impacts on the scheme much clearer than simple maps."

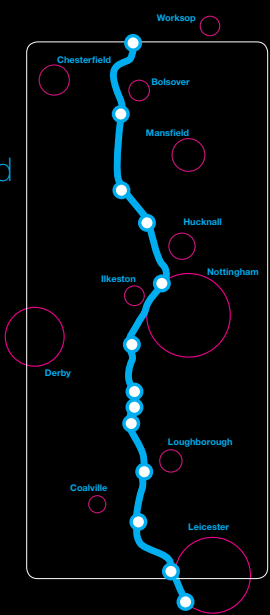
Resident, Leicester

"Well done – it's nice to have one's opinion sought and great to be kept informed."

Resident, Kirby Muxloe



Responses taken at consultation exhibitions (far left) could be plotted both geographically and by issue (left), to sensitively respond to residents' concerns along the project corridor (right).





The bridge of size

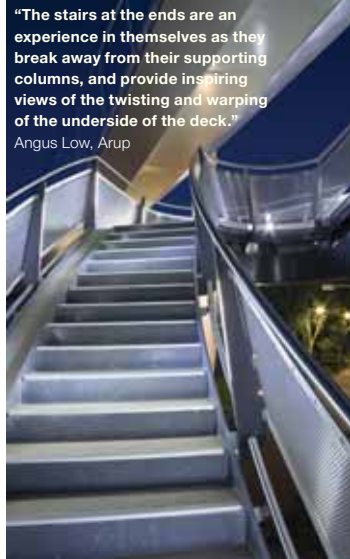
A new environmentally-sensitive cycle and pedestrian bridge, **Nesciobrug**, now stretches over the Amsterdam Rhine Canal and is one of the longest footbridge spans in the world. For residents of Amsterdam's new suburb, Ijburg, it's a priceless link across the water.

- Steel structure 220m in length
- Main span 170m
- Width 3.5m cycleway, 2m footway
- Contract value €12.2M

Scope



Nesciobrug caters for the needs of its users – pedestrians, cyclists and river users alike.



“The stairs at the ends are an experience in themselves as they break away from their supporting columns, and provide inspiring views of the twisting and warping of the underside of the deck.”

Angus Low, Arup

➤ IJburg sits on reclaimed land surrounded by water. Widely considered to be a ‘showcase’ community for future land development, this new suburb is a study in environmentally-sustainable living. Consequently, it is essential to offer a means of travelling to and from IJburg that does not result in exhaust emissions.

Throughout the design and construction of the Nesciobrug, Arup’s team of engineers took the relationship between pedestrians, cyclists and waterway users into account, without compromising the bridge’s structural integrity or the client’s vision. At the preliminary design stage, the local navigation authority performed computer simulations that showed the bridge might mask the radar image of an approaching ship. This resulted in changes to the side of the bridge to give it sufficient ‘stealth’ characteristics and deflect radar beams away.

“Constraints provide the opportunity to explore new ways of problem solving.”

Angus Low, Arup

Constraints to the approaches on both banks and a 170m span – one of the longest footbridge spans in the world – meant the rigidity and safety of the structure were a concern from the beginning.

“Constraints like these are challenges, not obstacles,” says Angus Low, lead engineer on the project. “They provide the opportunity to explore new ways of problem solving.”

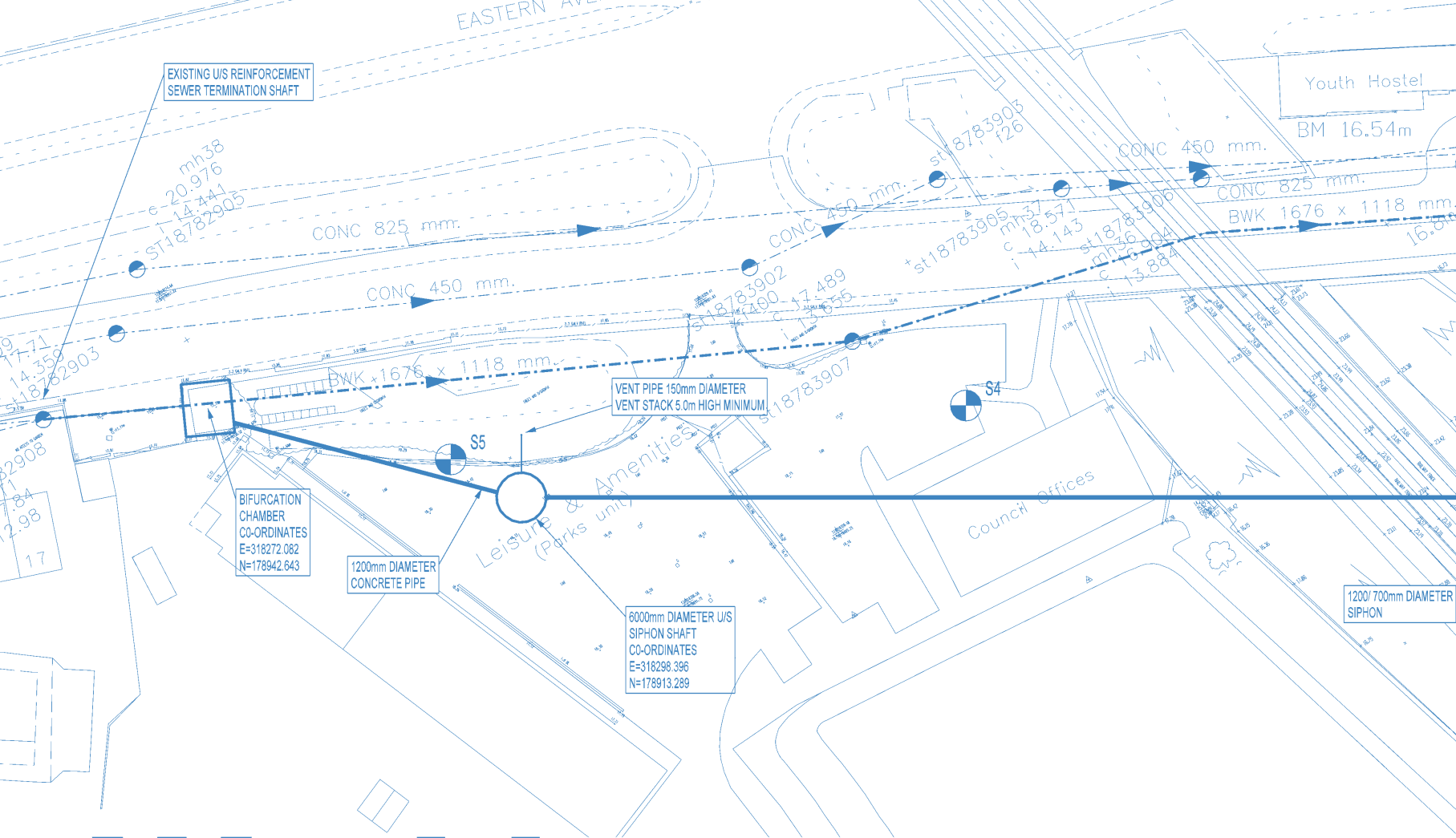
Working closely with Wilkinson Eyre Architects, Arup developed a design for a spectacular single-cable suspension bridge soaring 10m above the water’s surface to allow canal traffic to pass underneath, and with a 275m looping approach ramp on the south bank. The ramp also provides a perfect viewing platform for wildlife in the newly-developed wetland habitat below.

The generous 5m-wide steel-box girder deck is curved to follow the cyclist’s natural path, with varying depth to provide protection against wind vibrations. At the exits, the path splits to allow pedestrians and cyclists to separate, while also improving the lateral stiffness of the structure. An added benefit is that this also ensures initial stability against foot vibration, but Angus says it was necessary to draw on past experience to consider the dynamic effects of large numbers of pedestrians. Arup’s seminal research into synchronous lateral excitation revealed that three sets of additional tuned dampers, weighing a total of 13 tonnes, were required.

Constructed using the very latest techniques, the result is a timeless classic of a bridge that is built to last. □

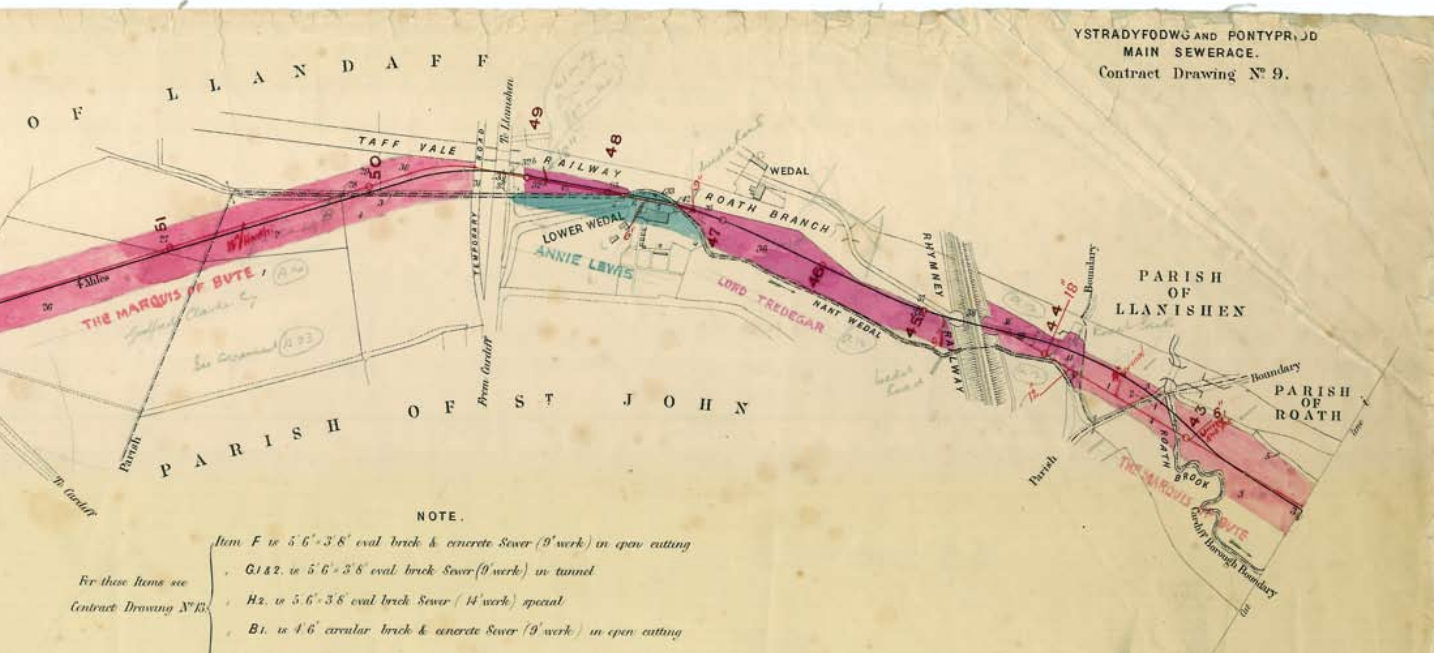
“Nesciobrug is an object of beauty to be enjoyed. Its design, the curves and the way the bridge is ‘snaking’ from one bank of the canal to the other is a great joy for everyone.”

R Hillhorst, IJburg project manager, City of Amsterdam

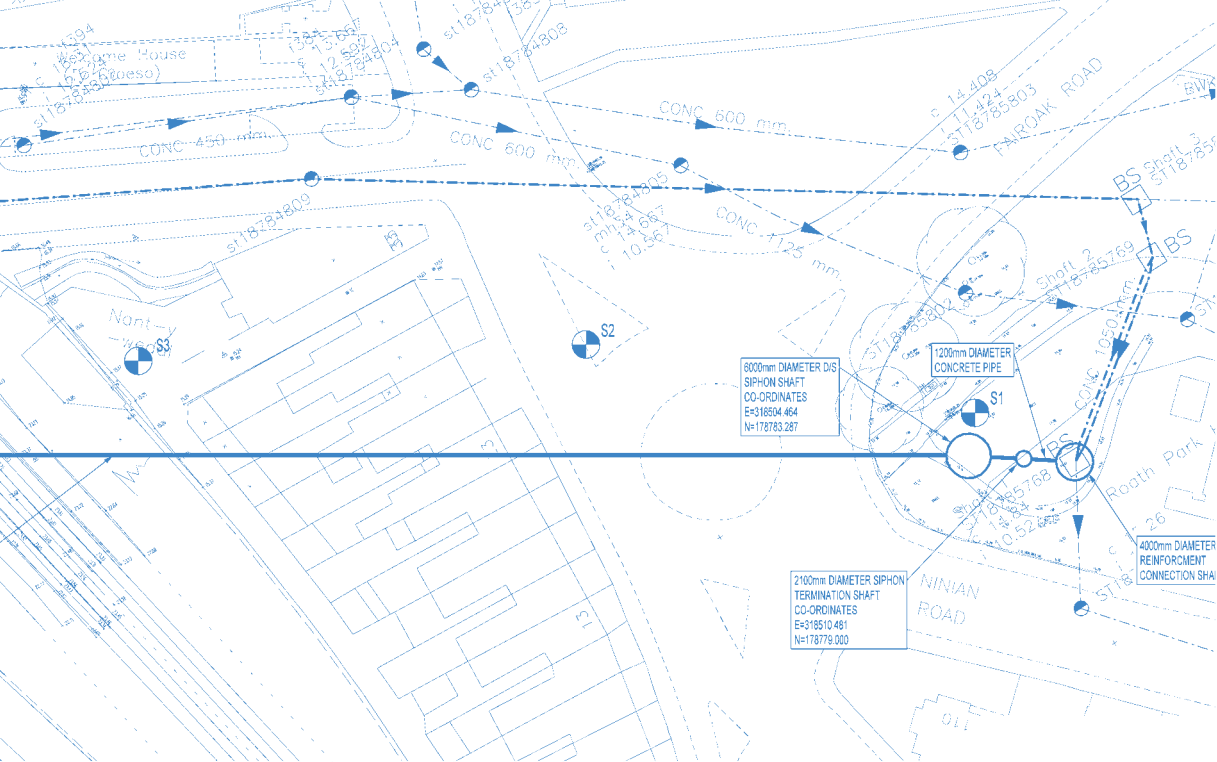


Washing water

Two very different ways of treating waste in two countries on opposite sides of the world are helping governments to clean up.



Bazalgette's original schematics (left) became a useful reference tool for Arup's engineers when they were developing their own plans (top).



Administrations in all countries will occasionally find themselves facing similar infrastructural issues. The growing challenge of treating rising amounts of sewage is a particularly pressing example.

In Wales, Arup's design team was tasked with reducing the flood risks in Cardiff's sewer network during severe storms. These flood risks are a consequence of the cumulative effects of climate change, population growth, rainwater infiltration and an ageing infrastructure. Under the Cardiff East Control Strategy, the solution has maximised the usability and life-span of existing sewers, while reducing flood risks and operating costs.

Cardiff's existing sanitation system was developed in the 1800s by Joseph Bazalgette, an engineer. Ahead of its time when built, the system required modernising some two centuries later – not least because historically it used to discharge into the River Severn according to the tides.

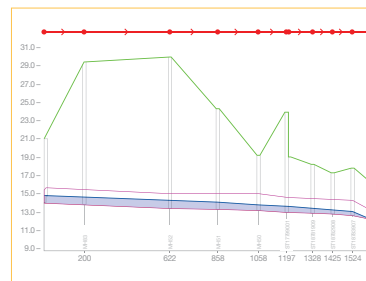
Arup's proposal was informed by a year-long study of the sewer network. David Evans, project manager, says the project is centred on a control philosophy which delivers increased operator control, optimised transport capacity, best use of inherent storage, zero flooding from sewers in severe storms and controlled discharge from overflows. The design process started during 2004 and the Cardiff East Control Strategy is expected to be up and running by September 2007.

Arup's system has not required vast amounts of storage compared with more expensive containment systems. Rather than provide extra storage, its strategy has been to manage sewage flows better. In order to meet these demands, engineers conducted a prototype test by closing the outfall from catchments, allowing the sewer networks to fill up in a few hours.

A 12-month flow-monitoring programme to assess the performance of the system followed. Arup has also proposed the creation of seven sub-catchment areas, each having its own primary point of relief to simplify the understanding and solution development.

Each sub-catchment area has one or more secondary points of relief for the management of flooding risks. It will also be used to reduce the effects of rising sewage levels to give a more strategic, catchment-wide means of relief. The whole system is automated, with a control system used to manage the process.

Arup's team believes the project will be the forerunner of similar schemes in urban areas. »

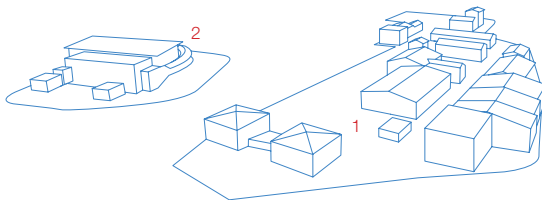


Modern technology allows the direction and location of sewerage systems to be carefully controlled, and volumes and flow precisely monitored (above).

Project characteristics

The estimated cost of the control strategy works is less than £3M. This compares with the £100M that would be required for 100 000m³ of new storage. Further characteristics of the plant include an automated system, which can be manually overridden. This system also has a high degree of security that minimises the margin for operator error.

Thinking green and clean played a big part in the design remit.



The Ngong Ping sewage works (2) have been designed to complement the existing cable car structures (1) and fit in with the surrounding environment.

➤ In Hong Kong, a new green strategy for the Ngong Ping sludge treatment project, which opened in March 2006, is helping the plant achieve maximum recycling efficiency. Arup's teams have been involved in designing and consulting on a new sewage system required to support a cable car facility.

Designed to contain 3000m³ of sewage per day, the system also requires a sewage collection network and an export pipeline to take the effluent away from Ngong Ping. The previous sewerage system in the area relied on distributed septic tanks and soak-away systems, which were very primitive by today's standards. Because the region is located in an environmentally-sensitive area, near the Shek Pik Reservoir, the new system had to be pollution-free. To meet this objective, Arup complied with the Environmental Impact Assessment Ordinance (EIAO), which required the appropriate environmental permits.

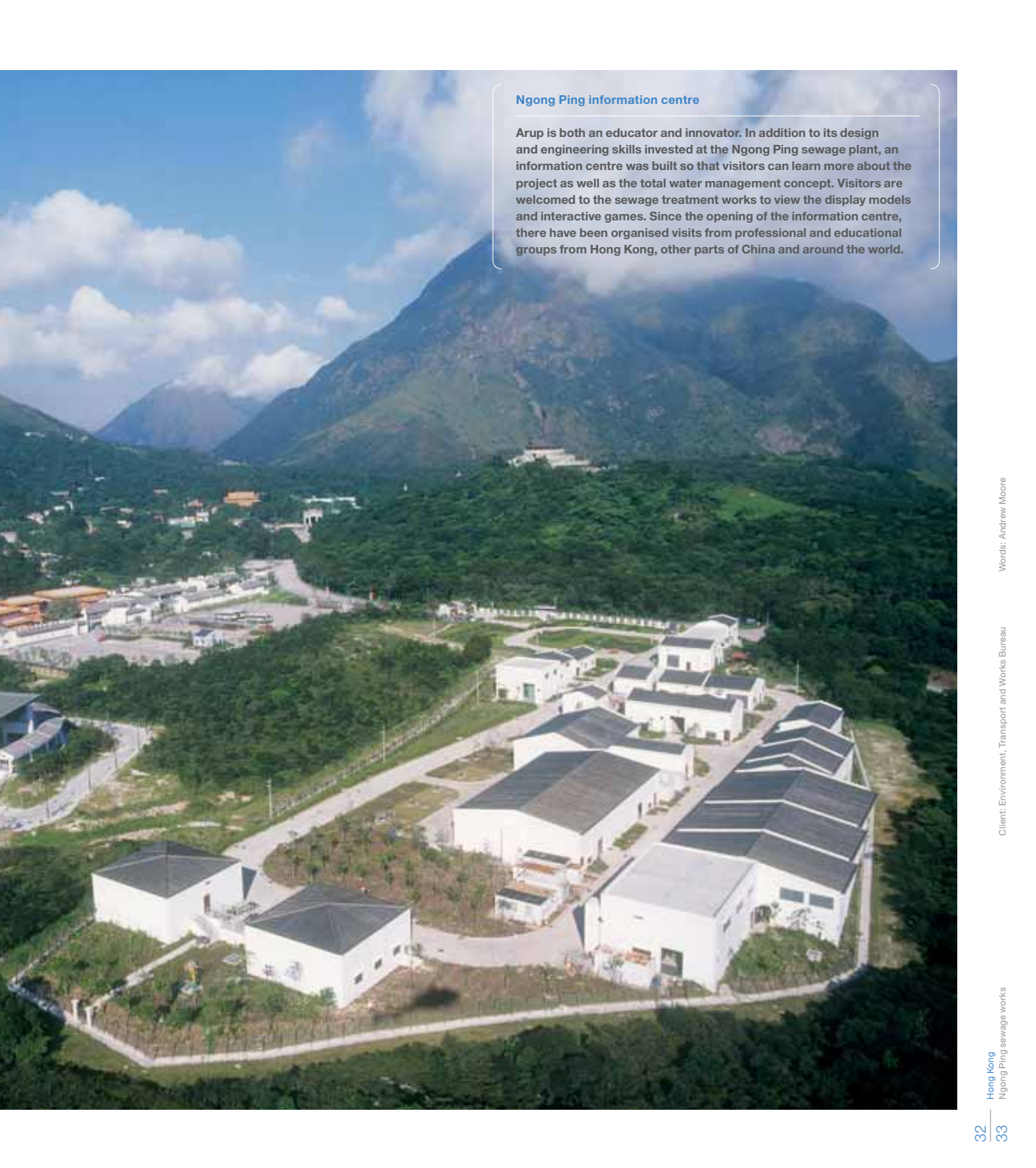
As part of the sewage treatment works, Arup's engineers devised a system that operates in four stages: incoming sewage undergoes preliminary treatment in an inlet works, then onto secondary treatment in a sequencing batch reactor basin. It is then passed onto tertiary filters and finally to a disinfection system.

A big problem was recycling as much effluent as possible with no leakage through the 5.7km export pipe. The design team proposed using a gravity discharge pipe, eliminating the need for a pumping facility. Again, 'thinking green and clean' played a big part in the design remit, and Arup delivered a number of environmentally-friendly solutions. These included specifying corrosion-resistant ductile iron for the discharge pipe; optimum spacing between manholes to facilitate inspections; back-up power generation and storage facilities to avoid the need for emergency discharges of raw sewage.

As part of the sewage treatment, sludge is passed through a centralised deodorisation unit. But Arup also had to ensure the plant did not deface the local environment. Under a landscaping scheme, the local environment was preserved by extensive tree planting and by building the structure to be compatible with the neighbouring development.

The project was completed six months before the opening of the cable car facility, to allow the necessary testing and commissioning – well ahead of schedule. □





Ngong Ping information centre

Arup is both an educator and innovator. In addition to its design and engineering skills invested at the Ngong Ping sewage plant, an information centre was built so that visitors can learn more about the project as well as the total water management concept. Visitors are welcomed to the sewage treatment works to view the display models and interactive games. Since the opening of the information centre, there have been organised visits from professional and educational groups from Hong Kong, other parts of China and around the world.

The construction of the latest landmark on Seville's landscape sees a remarkably futuristic-looking project built on foundations that are several thousand years old.

Spanish legend has it that Hercules originally used six columns to mark the spot where Julius Caesar would later found the city of Seville. Perhaps appropriately, a new building that marks the site of recently discovered ancient Roman ruins echoes this ancient piece of Seville's cultural heritage.

The Metropol Parasol is the redevelopment of an existing plaza in the heart of Seville's city centre. Originally planned and designed as a standard (if sprawling) shopping complex, the discovery of the archeological site during the excavation work for an underground car park changed everything.

Wishing to mark the site in La Plaza de la Encarnacion appropriately, the centre of a relatively poor residential area in northern Seville, the City of Seville announced a competition calling for a more imaginative development. Architect Jürgen Mayer H and Arup's Berlin team jointly submitted the winning plans for what will become one of the largest architectural timber structures ever built.

"Our vision was so bold that we were initially a little surprised that we'd won," comments Jan-Peter Kopitz, a project manager at Arup. "It immediately became clear that the City of Seville was very serious about establishing a bold new landmark to help regenerate a disadvantaged part of Seville – in much the same way as the Guggenheim Museum helped to transform Bilbao's reputation and appeal."

With such a rich seam of existing architecture running through its streets, the new landmarks on Seville's block must be truly groundbreaking if they are to create their own spectacle. The Metropol Parasol is defined by six mushrooming 'parasols', supported by six columns, to provide a large area of welcome shade from Seville's prohibitive sunshine. Its remarkable futuristic design, combined with the sustainable construction that has already won the bronze medal from the Holcim Foundation for Sustainable Construction, ensures that its architectural pedigree is equal to that of its neighbours.

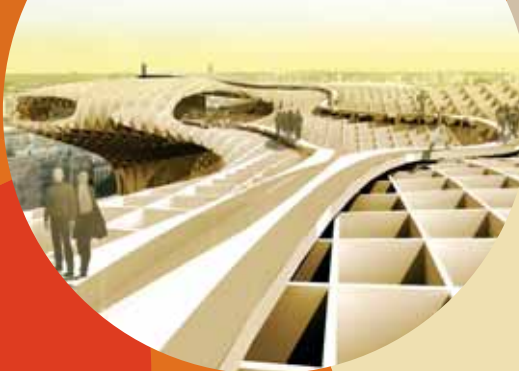
The Metropol Parasol's foundations are all designed around the extensive Roman ruins, which were found largely intact and date as far back as the 1st century AD. They include mosaics of internal residential patios, a Roman street stretching from the city centre to the Guadalquivir river and a Christian church thought to date from around the 6th century AD. Basement areas have been planned outside the important ruin zone and a steel structure supporting the new farmers' market and elevated plaza is constructed from 40m

Shades of Seville

© J. Mayer H



The whole site will be shaded by the structure's six enormous parasols. These are made from timber plates covering an area of 150m x 70m.



Walkways on top of the parasols mean the visitors can enjoy the beautiful views overlooking the historic town centre of Seville.

long-spanning steel frames. In addition to the market, plaza and museum, the site incorporates multiple bars and restaurants underneath and inside the parasols and a panoramic walk at the very top.

For Jürgen Mayer H and Arup's teams, who assumed full responsibility for the structural, mechanical, design and fire elements of the project, the materials and geometry are the two aspects that make the Metropol Parasol so exceptional.

The lightweight timber, polyurethane-coated construction has resulted in the structure being climatically sensitive and able to generate its own low-level air-conditioning. Its coating ensures the timber will retain its structural characteristics for its entire life-span and will only need repainting every 20 to 25 years. These

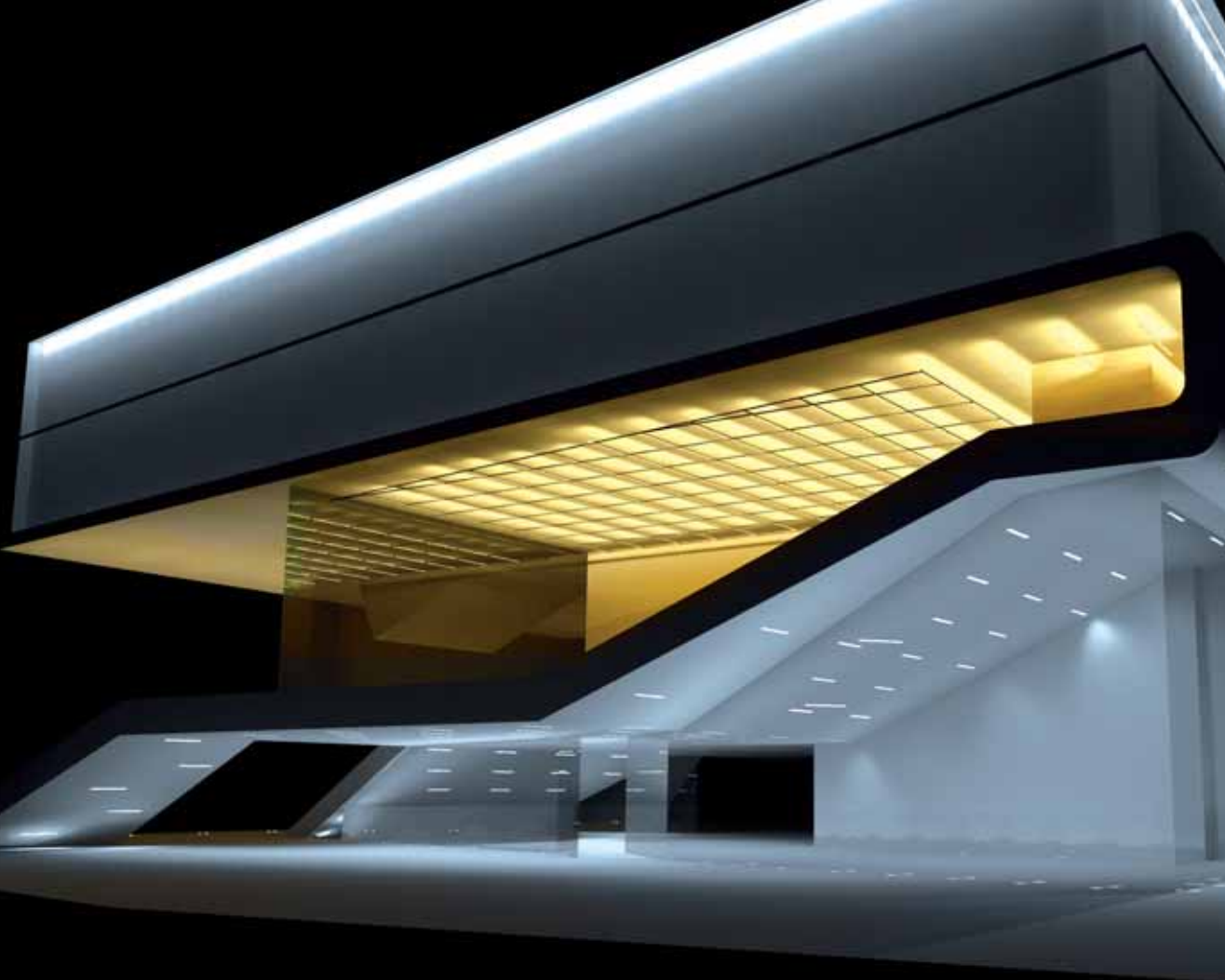
low maintenance requirements mean that continuous renovation work will not blight local enjoyment of it.

"The timber beams have been placed every 1.5m to form a kind of grid system," explains Volker Schmid, structural leader at Arup in Berlin. "They are exceptionally light and the structure itself has been designed to let light and ventilation through. There's still a good amount of shading, as that is what will attract visitors and encourage them to linger. Because the boundaries constantly curve and sweep, no two beams are the same – every element is unique, like the finished product."

Planned for completion at the end of 2008, the Metropol Parasol is already generating widespread interest. Its six supporting columns are prominent points of access to the museum below and the plaza and panorama deck above, defining the unique relationship between the city's historical and contemporary heritage. □



A restaurant 22m above ground is expected to become a unique visitor attraction at the Metropol Parasol.



Bright ideas

Getting the lighting right can make all the difference to a project's success. Arup relies on a dedicated team to invest its projects with imaginative and inspiring lighting.



Design tailored to an art museum's needs

Arup was asked to provide a lighting solution allowing Boston's Institute of Contemporary Art to display a variety of works in close proximity. Although a video installation needs low ambient light levels to be viewed compared to a sculpture, both would be sited within the same open plan gallery and needed to be lit appropriately.

Working closely with project architects Diller & Scofidio, Arup proposed a solution relying on daylight entering through roof lights and into the gallery through a light diffusing ceiling.

Light in the 1672m² open gallery can be separately controlled for areas as small as 3.6m x 3.6m through a motorised shade system. This ceiling system also integrates other Arup engineered services, including structural strong points, smoke detection, sprinklers and low-voltage electrics.

"The lighting concept ended up driving key structural decisions," says Arup lighting designer, Brian Stacy. "The gallery lighting system had to be incorporated into a thin sandwich below the light loft, creating a combined effect of natural and electric light."

➤ In recent years, as clients have increasingly requested lighting design to be incorporated into their projects, Arup has begun to recognise it as a discipline in its own right. Now part of the larger Arup offering, early commissions included work for some prestigious projects, including the Richelieu Wing of the Louvre in Paris.

Since then, Arup has successfully completed the lighting for a series of high profile public buildings and is growing its portfolio of privately commissioned works.

There are now teams based in London, Amsterdam, New York, San Francisco and Melbourne, with some team members drawing on theatrical experience. These teams work closely with clients and colleagues from other disciplines to ensure that lighting considerations are at the heart of design from the earliest possible stage. This is particularly true of a project at the Institute of Contemporary Art in Boston, and a major lighting initiative for Louis Vuitton. »

"Imagine going to a hotel where you can change the colour of your room to suit your mood."

Rogier van der Heide, Arup

What a difference a lux makes

We often respond to light at an instinctive level, for example turning the lights on at home to help us feel cosy and warm.

Different kinds of light evoke different reactions and moods: inspiring, dramatic, romantic – the options are endless.

Traditionally, designers have measured light in its basic unit: the lux. A candle at a distance of 30cm provides around 10 lux, offices are typically lit at 400 lux and sunlight can top 100 000 lux. While this measure remains important, there is more emphasis now on shaping and channelling light to achieve particular effects.

Today, lighting offers a versatility undreamed of ten years ago. For example, miniaturisation of light sources now means that light can be sculpted and enriched, and the convergence of video and lighting presents opportunities to turn entire building façades into 'living' surfaces. This approach has been used to dramatic effect on a department store project in Taiwan, allowing textures and colours to sweep across a massive area.

"Lighting can also help personalise spaces," says Rogier van der Heide, global leader of Arup's lighting team. "Imagine going to a hotel where you can change the colour of your room to suit your mood, or project a selection of your favourite artwork onto the walls."

Although lighting might appear abstract compared to the physical aspects of building design, Rogier is convinced it can add value to clients' projects.

"With the right lighting, people will choose to spend more time in a particular space. In a public building this gives the administrators a chance to promote forthcoming events; in a retail store, customers may end up making additional purchases."

Arup's lighting team relies on a set of tools such as table-top models and computer simulations to help understand how light will work within a particular space. Weather data also helps ensure the lighting design will be complemented by patterns of natural light. Close collaboration with clients and architects at every step ensures the final result meets or exceeds everyone's expectations. □



Icons in the spotlight

Louis Vuitton luggage and handbags are iconic; instantly recognisable as design classics. The products' status was at the heart of Arup's lighting design for the company's stores – the specialism's first global retail project.

Working with interior architect Peter Marino, Arup's design team replaced tungsten fittings with HID (High Intensity Discharge) fixtures hidden above the ceiling, channelling their light through a narrow slot. Energy and maintenance costs have both fallen by about 65% thanks to the use of these lights, which have replaced conventional halogen bulbs.

A virtual absence of ambient lighting – in a direct challenge to received retail lighting wisdom – also means that the light sources are focused entirely on the products. The effect is to allow the products' craftsmanship and elegance to speak for themselves, without unwelcome distractions.

The Jeddah City Masterplan (pictured) uses buildings to channel breezes, offering respite from the heat to significant areas of the city.

Improving outdoor comfort

Stay cool

► The design of microclimates enables people in hot countries to keep their cool – both indoors and out – and is increasingly on the list of ‘must-haves’ for clients.

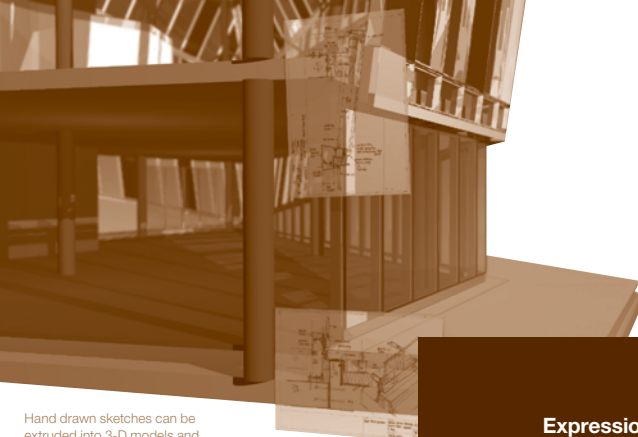
Using advanced computational analysis and design skills to control radiant temperatures, air movement and air temperatures, Arup can increase the usability of outdoor and transition spaces during thermally-uncomfortable seasons. This is of added value to the client, as buildings with greater usability attract higher prices, making them more profitable to developers and investors. This work also potentially improves the sustainability of a development.

Microclimates in practice

With temperatures regularly reaching 35°C (95°F) or more during the day and 25°C (77°F) or more during the night, Arup was asked to guide the masterplanning process for urban scale developments in Jeddah. This was to ensure it would be a more comfortable place to live and work for a larger part of the year. Arup initially generated principles for promoting wind penetration into the courtyards of residential block developments using orientation, spacing between blocks, aspect ratios of the courtyards and porosity of the buildings at a local and wider scale as the prime variables. These principles, combined with further computational fluid dynamics (CFD) studies, were then applied to a first phase and future plan for the central business district and also for developments on neighbouring islands. The building massing strategy was guided by examining the potential impact of blockages, channelling, breezeways and tall buildings on the pedestrian environment.

In Doha, Qatar, Arup advised on the masterplan design for a major development in order to produce an urban form applicable to the Qatari climate. Wind, sun and climate data were analysed in detail and the layout of the site was conceived to maximise shade and channel sea breezes. Arup’s input enabled the development to be planned to reduce the ‘urban heat island’ effect – reducing the heat gain to buildings and improving external conditions to encourage pedestrian circulation on the site.

Ultimately, Arup’s microclimate design expertise is making developments in hot global locations more usable, prolonging the time people can enjoy the outdoors. □

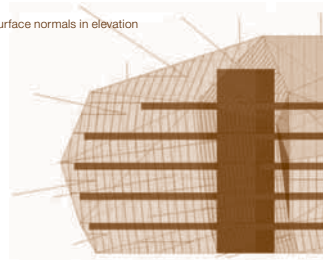


Hand drawn sketches can be extruded into 3-D models and play a key part in communicating the architect's vision.

Expression – whether it's a photo, doodle, or 3-D drawing – invites shared vision.

It was during work on the headquarters of the Allied Irish Bank in Dublin that Arup's facade engineering team first developed the sketchbook approach. "We were keen to provide something to explain what we were doing, instead of just giving the client a *fait accompli*," says Arup engineer Duncan Richards.

Surface normals in elevation



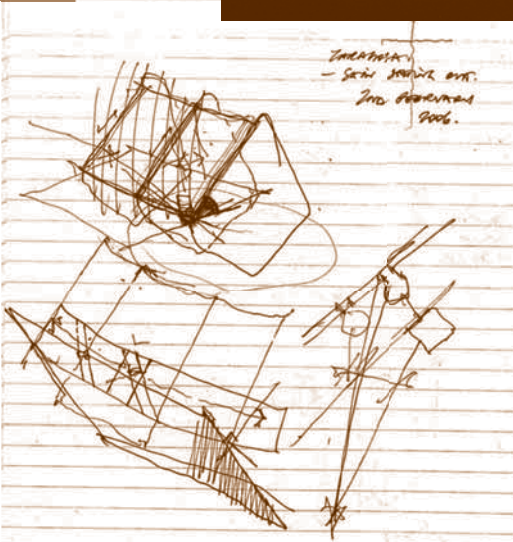
Behind the creative process

A 'sketchbook' is essentially an A3 document that can include CAD images, freehand sketches, doodles, photos – anything that can help to articulate the creative process. These sketchbooks give everyone involved in any project the same vision. They promote dialogue and provide an intelligent audit trail to aid communication

When words

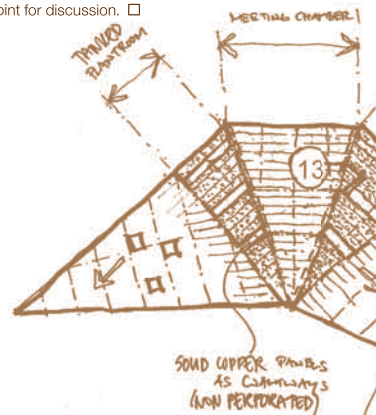


are not enough

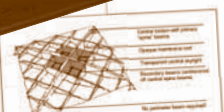


between contractors, suppliers and other specialists who may not normally be involved in the project during the early stages.

Duncan believes the effect of this 'visual brainstorming' makes group working more cohesive, because everyone has a focal point for discussion. □



A sketchbook can include anything



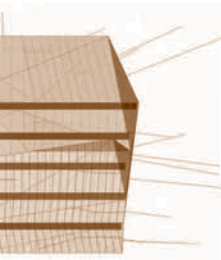
ARUP
Heathrow East Terminal
 A/E and cladding Sketchbook -
 draft 1 - 21 dec 06

1- Big scale ribbed structure
 This structural system uses shaped ribs which could also be replaced by tube structures, or square tubes, or even solid beams, and appropriate fasteners at the joints, under the ribbed structure.

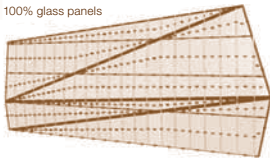
This is the only structural option considered that does not require a significant edge beam to span the gap between ribs across the width of glass units. It will allow all other materials like stone or granite, metal, etc. to be used in the cladding system.

A fully glass ribbed structure would create and shed a wind tunnel in the main station area. It would also require the following:

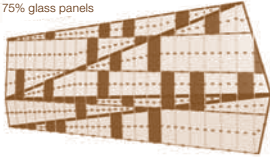
SH...
 CAN...
 RA...



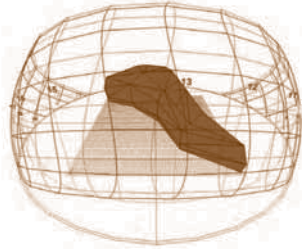
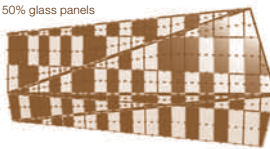
100% glass panels



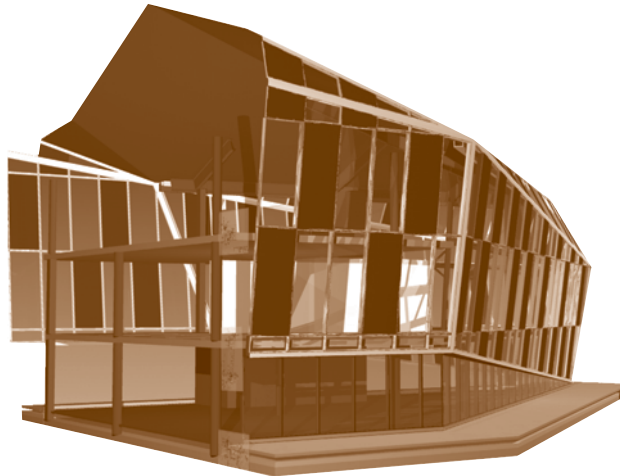
75% glass panels



50% glass panels



Sun path and model of the building



"By making the client part of the legacy of the project from square one, sketchbooks give the client the confidence to make more informed decisions."

Duncan Richards, Arup

The Gorse Stacks project – an irregular shaped glass building – used the sketchbook approach to find a way of introducing uniformity without a loss of vision. This will keep construction costs down, speed up the build time, yet keeps the structure's unique shape intact.

A 3-D view of cost implications
The Gorse Stacks building in Chester, UK, uses faceted, irregular, flat surfaces to create an exciting, stealthy geometry. The sketchbook approach helped to demonstrate how Arup had interpreted a design that required many uniquely shaped glass panels, into one that employed panels of a standard shape and size. All of this was achieved without losing the vision of the original design.

"The increased simplicity our 3-D modelling showed us how much easier we could make the building process," says Arup engineer Graham Dodd. Savings of approximately £250 000 are expected.

A river runs through it

The beauty of the new football stadium for Valencia CF is more than skin deep.

Although Valencia CF's new football stadium will be built outside the city, the design that weaves across the building's outer skin retains strong links with the city's heritage.

The architectural design by Arup and Reid Fenwick Associates mirrors the river Turia, diverted from Valencia in the late 1950s after a flood and now home to a massive city park – a source of immense local pride. Around this river design is a plan of the city, with each neighbourhood represented on the aluminium shell of the stadium's uniquely shaped bowl.

The new stadium, Nou Mestalla, will replace the Estadio Mestalla, home of Valencia CF since the 1920s. Nou Mestalla will be an ideal venue for a UEFA Champions League Final.

It's not just football that will benefit from Nou Mestalla. An athletics track that can also be constructed over the lower seating tier for major events makes this a multi-functional stadium. And by incorporating the roof support structure into the top seating tier, unrivalled space is offered despite a small footprint.

To help tackle the punishing local climate, where temperatures can soar to more than 45°C (113°F) in the summer, the decorative external skin also allows controlled ventilation of the internal structures. □

Clear lines of sight

The ability to watch matches unimpeded by fellow fans or stadium pillars is a prerequisite for modern stadium design.

Not only must the view directly ahead be clear, but diagonal views to the nearest corner flags should offer clear visibility too.

Powerful computer simulations have enabled Arup to determine the quality of view from every seat in the stadium.



The Stratford City masterplan sees the derelict rail yards in Stratford, East London, transformed into a new mixed-use metropolitan centre for London, with high speed European trains at its heart. A significant part of Stratford City will be the athletes' village for the 2012 Olympic Games.

Fast forward

Originally to be carried out over a 20-year period, Stratford City's major regeneration has become an important component of London's 2012 Olympic Games developments.

➤ The development of Stratford City is one of the largest and most complex mixed-use projects of its kind ever undertaken in the UK. Arup's urban design team, working with West 8 and Fletcher Priest Architects, in conjunction with Arup's civil engineers, transport planners, environmental engineers and sustainability teams devised a framework dividing Stratford City into four new urban districts whose different characters are determined by the differing characters of the existing neighbouring environments.

The scale of the project necessitates an inherent flexibility while still creating a clear vision and sense of place. In order to achieve this the masterplan sets out a core 'anatomy' made up of the primary movement network, open space structure and building massing. Around this framework a variety of use distributions can be developed in detail.

Though the masterplan for Stratford City's redevelopment was in place long before London's Olympic bid began, in selecting the area directly to the west of Stratford City for the 2012 Olympic Games, the International Olympic Committee cited the regeneration plan as a factor supporting its choice of venue.

"Originally the development of Stratford City was planned over 15-20 years. With a significant part of the residential areas in Stratford City becoming the athletes' accommodation for the London 2012 games, this time frame has changed significantly," says Arup urban designer Elke Sindlinger.

"The flexibility built into the masterplan was based on the need to integrate with a changing context while still maintaining the core vision of a new metropolitan centre for East London."

Project notes

- Stratford City is a new metropolitan centre for London, comprising a mix of uses, including 175 000m² of shopping and entertainment space, three flagship stores and more than 200 retail units and restaurants.
- New houses and flats will accommodate 11 000 residents and most of the 2012 Olympic athletes.
- Office space for over 30 000 people will be created.

The town centre district, the first piece of Stratford City to be implemented, is an extension of the existing town centre and is made up of a mixed-use, retail led environment. This phase of development also provides the strategic connection between Stratford International station and the existing regional station.

Following closely are the districts to the north of the site, which is the primary location of the athletes' village for 2012, and a new urban residential district for Stratford, post Games. As each stage takes shape Arup constantly assesses factors such as sunlight, daylight and wind patterns to ensure the components fit together in an integrated design that conforms to the leading environmental standards.

The framework laid down by the masterplan aims to create a new piece of city that integrates into the changing context of Stratford. The capacity for it to accommodate the unexpected need for an athletes' village illustrates its capacity to adapt to changing needs which gives confidence that it will be a sought after part of the urban landscape of London long into the future. »

A vision of the future:
how the new Stratford
City will look.

· ppt16-17 Jinan Tangye masterplan



Keeping things moving

Transport is key to the masterplan. Proximity to public transport connections such as the Channel Tunnel Rail Link (CTRL), mainline rail services, the London Underground and the Docklands Light Railway will play an important role in the area's renaissance.

By successfully lobbying for the CTRL to pass under the Thames, thereby connecting the Midlands and North with Continental destinations such as Paris and Brussels, Arup has helped to shape these connections and enable significant regeneration, at not only Stratford, but in the Thames Gateway, too. Originally, the plan had been to end the link on the south of the river.

The large amounts of spoil from this CTRL tunnelling work have been heaped on the Stratford City site, to lift it out of the flood plain and enable regeneration to occur.

Although normal access for cars and commercial vehicles will be needed on the site, the focus is firmly on promoting walking, cycling and public transport, to realise the full potential of the new and existing transport infrastructure. The emphasis on open space has resulted in the site's reconnecting unique open spaces of the Lea Valley, with the urban heart of Stratford and its surrounding neighbourhoods.

All these considerations are underpinned by a sustainability strategy that examines energy sourcing, waste management, biodiversity, water efficiency and microclimates on a site-wide level, rather than focusing on individual buildings. □



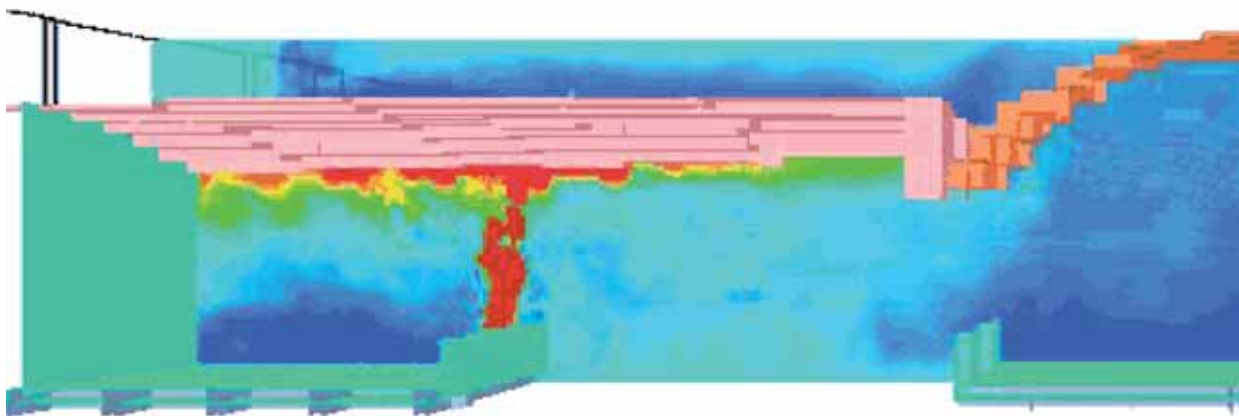
“The flexibility built into the masterplan means we can tailor work in conjunction with the Olympic site, while still maintaining our core ambitions.”

Eike Sindlinger, Arup



The flame game

The unique fire risks of individual structures require bespoke solutions.



Innovative solutions for open spaces in China

At nearly 560 000m², Guangzhou Railway Station will be the largest station in the south of China.

When completed in 2010, the station will include 15 island platforms and 28 railway lines, catering for 78M passengers a year. The three-storey construction will feature an arrival level, a platform level and, at the top, an elevated departure level.

Such a massive and busy structure poses challenges for fire safety experts. The open-plan design prohibits the installation of traditional safety measures such as fire shutters, so alternatives have to be found.

Arup's Shenzhen office used advanced computer modelling techniques to arrive at a solution that uses natural ventilation to tackle the fire risk, rather than a mechanical system relying on complex ducting and fans. This approach employs large voids above the platform and departure levels to channel potentially harmful smoke away from passengers.

Areas at higher risk of fire such as shops are protected using the 'cabin concept', which aims to contain fire as long as possible while the station is evacuated. To tackle the risk of fire in the station's open spaces, the team from Arup proposed a long-throw sprinkler system or water cannon.

In the event of a fire, people would be guided to safe zones on the same level, avoiding the need to design many staircases in large circulation areas.

The Arup team's proposals were approved by the Chinese authorities in November 2006. □



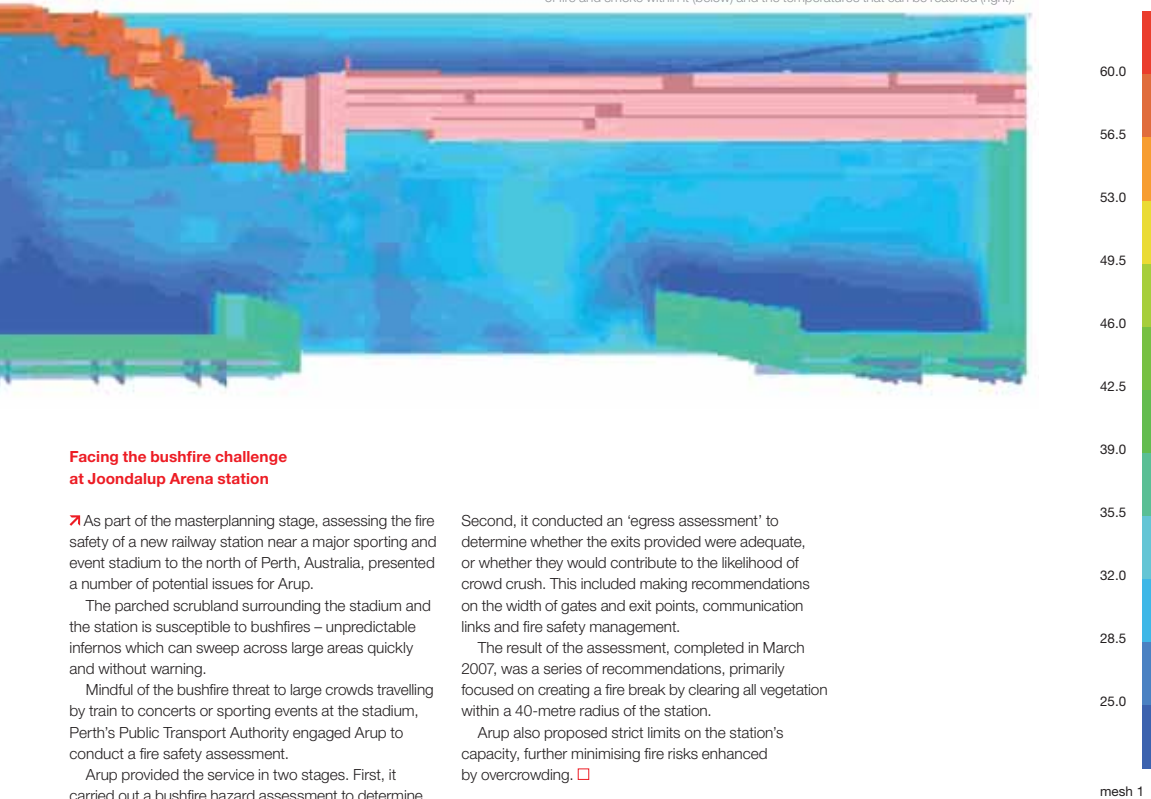
Above:
Large roof spaces have practical safety functions.



The route to Joondalup station stretches across tinder-like scrubland.

Bushfires: unpredictable infernos which can sweep across large areas quickly and without warning.

Computer modelling can identify how a building's shape can influence the behaviour of fire and smoke within it (below) and the temperatures that can be reached (right).



Facing the bushfire challenge at Joondalup Arena station

➤ As part of the masterplanning stage, assessing the fire safety of a new railway station near a major sporting and event stadium to the north of Perth, Australia, presented a number of potential issues for Arup.

The parched scrubland surrounding the stadium and the station is susceptible to bushfires – unpredictable infernos which can sweep across large areas quickly and without warning.

Mindful of the bushfire threat to large crowds travelling by train to concerts or sporting events at the stadium, Perth's Public Transport Authority engaged Arup to conduct a fire safety assessment.

Arup provided the service in two stages. First, it carried out a bushfire hazard assessment to determine the likelihood of it affecting the station.

Second, it conducted an 'egress assessment' to determine whether the exits provided were adequate, or whether they would contribute to the likelihood of crowd crush. This included making recommendations on the width of gates and exit points, communication links and fire safety management.

The result of the assessment, completed in March 2007, was a series of recommendations, primarily focused on creating a fire break by clearing all vegetation within a 40-metre radius of the station.

Arup also proposed strict limits on the station's capacity, further minimising fire risks enhanced by overcrowding. □

Arup's team of engineers worked with developer Stanhope and architect Kohn Pedersen Fox to realise the vision on this project, which includes revolutionary 'Flying Carpet' floors (pictured).



Young on the inside

Carefully combining new engineering techniques with existing structures can save time and money.

When redeveloping the iconic Unilever House on Blackfriars Bridge in London, the exterior of the 1930s Grade II-listed building needed to remain unchanged, while the interior, which was not listed, was to be completely demolished and refurbished. The work included extending the existing floor plates and constructing a new stability system and atrium with four levels of suspended break-out space. The result was to be a marriage of decades-old architecture with completely modern technology.

Forward thinking

"Finding the right approach to the project was made easier because there was detailed archive information available about the building's design," explains Ben Tricklebank, Arup's structural team leader on the project. "We were able to work from the original 1930s drawings and site records, together with articles written in magazines. This started the project off on the right foot."

However, there were ambitious cost and deadline constraints for the scheme. Design work on the £90M redevelopment began in 2003 and had a completion date set for March 2007.

Along with the archive information, engineers conducted a site investigation and structural surveys of the building's existing construction. Through careful and methodical planning, Arup worked on a design brief to knit old and new architecture together. This simplified the retention of the façade on the building's two main elevations by keeping part of the existing floor structure and foundations underneath it – an innovative approach that saved time, money and a lot of effort. To be able to re-use the original foundations in this way, and to support the new construction, Arup's team of engineers relied on the available data to confirm that the piles were fit for purpose. This was vitally important if the new internal structure was going to stay in place.

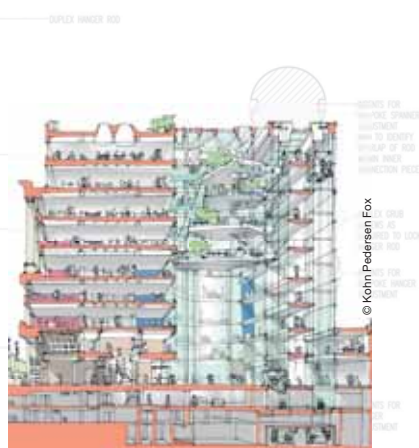
Reusing the existing foundations required significant design work, but resulted in substantial cost savings. Further savings were made using a revised structural frame that incorporated steel beams and concrete walls to distribute the new loads back to the original column locations.

Time is money

In addition to cost cutting, Arup shaved time off the project schedule. Digging caissons by hand saved eight weeks on the construction programme, allowing construction to be undertaken during the demolition phase. Further ingenuity was applied to the building's new showcase space. Between the lower ground and the first floor, a double-height space was created to link the new atrium to the northern Watergate elevation. Blending old architecture with modern engineering brawn also led to the creation of the so-called 'Flying Carpets'.

Arranged as four irregular-shaped floors, the Flying Carpets are communal areas dramatically suspended within the upper atrium and linked to the surrounding office floors via steel and glass bridges. These are held in place by a minimal system of high-strength stainless steel tension rods attached to the main building at roof level. Arup's finishing touch to the project involved linking the Flying Carpet floors with a spiral staircase.

By mixing old engineering with new, a quick, cost effective solution has been found that does justice to both the established aesthetics of the building, and the needs of the contemporary office. □



Restoring the iconic building (above) benefited from the early digging of deep caissons (below), which later helped to support the new internal structure (top).



SECTION THROUGH THE BUILDING TO SHOW THE STAIRCASE AND THE STAIRCASE.

© Kohn Pedersen Fox

Words: Andrew Moore

Clients: Unilever / Stanhope / Bovis Lend Lease

Plane and simple

With its rapidly accelerating economy, China is all too aware of its environmental responsibilities and the need to champion 'green building'. This is especially visible in the masterplan and terminal building concept for Kunming Xiaoshao International Airport, in Yunnan province, south west China.



“The design integrates the area’s topography with architecture, function, landscaping, transport organisation and Yunnan province features as a whole.”

➤ Set to open in 2010, Kunming Xiaoshao will be China's fourth largest airport. It will set the standard for airport sustainability without compromising aesthetics or the need to safely and efficiently handle 60M passengers per year.

Arup drew resources from its different aviation teams – planning, baggage handling, cargo specialists, civil and structural engineering, transport planning and fire and safety – to assemble an integrated, multi-disciplinary airport design. Working in close collaboration with architects at SOM, each discipline was broken down into different sub-groups, overseen by project managers based across three continents. The task was to co-ordinate their part of the overall masterplan.

Together the team worked to the requirements and constraints of the brief to design a complex centred on a dramatic, single-roof terminal building, evoking the culture and beauty of the Yunnan province.

The layout of the airport, both inside and out, has been optimised to reduce manpower, energy use and emissions. Key to this is an efficient airside configuration that reduces ground delays and fuel burn emissions.

“On take-off and landing, regardless of what else you do, you're still going to have a similar level of engine emissions,” says Arup's Martin Landry. “So the place to make an environmental impact is on idling and taxiing time, both before and after take-off, when the plane has to taxi to the gate. By positioning the terminal building closer to the runway and by providing an efficient airside circulation network for both aircraft and airport vehicles, Kunming will be operationally more efficient, reduce operational costs for airlines, and will generate significantly less CO₂ pollution. Minimising the baggage tug circulation by offering decentralised baggage handling will add to these benefits.”

In addition, a rail link to the airport arrives directly under the terminal to reduce road use.

Keeping costs down is also a high priority for Kunming Xiaoshao. Among the many cost saving initiatives, having a single-roofed terminal enables

the reduction of facility requirements and manpower to operate it. Yet this is a design which combines both creativity and functionality. The aesthetically-pleasing intertwined ribbon-roof supports address issues such as seismic safety, thermal expansion and long-term spatial flexibility. This high roof is also a key safety feature in the event of a fire, allowing smoke to be drawn away from the crowds below and aiding clear evacuation.

A phased development approach will promote further cost savings and minimise initial capital investment.

Alternative site development facilities integrated into the overall airport plan present Kunming Xiaoshao with the opportunity to generate its own revenue. Central to these opportunities is an area called Airport City, which enables support activity to be closer to the airport, improving the project's operational efficiency and reducing emissions even further by cutting the distance between the airport's main sites.

Similarly, a Cargo City is planned to the south east of the terminal, linked by a tunnel to the main airport, where it is hoped freight operators will take out a lease on the land. With over 30% of overall air freight growth worldwide predicted to come out of China over the next 20 years, the opportunity for Kunming Xiaoshao to be financially sustainable as well as environmentally sustainable is huge. The majority of these benefits are a direct result of designing around the concept of operational efficiency. □



• 4 runways
• 112 arrival/departure gates
• Cargo facilities capable of handling up to 2.1M tonnes each year

Scope



"The Arup team shared Grocon's passion for the MCG project, and pride in the timely delivery of this magnificent sporting stadium."

Daniel Grollo, CEO, Grocon.

- Stadium capacity: 100 000
- Design programme: 12 months
- Construction time: 3 years

MCG



Bowled over

While the Melbourne Cricket Ground (MCG) makes a magnificent statement, the new roof over the Northern Stand makes a particular impression.



➤ The brief was clear: the MCG's Northern Stand was to be redeveloped in time for the 2006 Commonwealth Games and should feature a new 55 000 seating area. But, as the stadium was home to the Melbourne Cricket Club and the venue for the Australian Football League grand final, sporting events had to continue to be hosted at the venue throughout construction.

Strategic planning was paramount if Arup and its joint venture partner Connell Wagner were to complete the work within the allocated twelve months and within the AU\$434M budget. The construction company carrying out the work was Grocon Pty Ltd.

The glass ceiling

One of the main focal points of the work was the new roof above the Northern Stand. As a key visual element, it had to promote the stadium as an iconic structure, and as a world-class sporting venue.

The innovative hanging roof design employed concrete as a permanent ballast to give it the strength to resist uplift wind forces. This complemented a network of high-tension steel cable supports designed to spread the load of the roof's weight, as well as any wind force. This approach reduced the required amount of counterweight by 50% in comparison to other cantilever roofs, and the result is transparent, elegant and light.

Beneath the roof

To accommodate the various sports at the Commonwealth Games, a new pitch and turf nursery was installed, with the capacity to completely replace the pitch with just ten days' notice. An athletics track that can be extended into the lower tier of seating when necessary has also been developed.

The result is a stadium true to its original iconic status while embracing new concepts within the requirements of the brief: □

Taxi ranks like this one are often a place where market traders set up stalls.

Moving forward

An effective transport system can mean the difference between boom or bust for a region. This is something that Arup knows only too well, and its experience in major transport initiatives around the globe makes it an authority on the social and economic impact of appropriate and well-planned infrastructure.

“In South Africa, many taxi ranks and rail stations can be regarded as ‘sinkholes’. They are unsafe and unattractive. This is a missed opportunity from a local economic development point of view, bearing in mind the large number of people concentrated around transport interchanges.”

Lisa Seftel, former Deputy Director for Public Transport, Gauteng

Gauteng Province Transport Precinct Initiative: creating a strategy of hope

➤ Twenty years of under-investment in South Africa’s public transport infrastructure has led to inadequate facilities for many of those who rely on it on a daily basis. Understandably, this has increased social tensions and contributed to the further decline of many inner city areas.

So the authorities in Gauteng, the country’s largest province, turned to Arup to formulate a new transport interchange vision. Arup’s experience with transport projects, in particular its involvement with the South African national network plan, gave it the appropriate tools to do the job.

Socially-inclusive planning

Arup worked on a series of workshops that ran over a six month period, which included transport officials and community groups from Gauteng’s metropolitan councils. These parties met to discuss issues such as the sustainability, design, construction, and commercial value of the project. This proved fundamental in developing a plan suitable for the region, and for the needs of the people who would ultimately be using the network.

“In the past, communities had been told ‘There’s the bus or railway station, take it or leave it,’” says Arup’s interchange and station lead designer, Leszek Dobrovolsky. “So this approach was very fresh and

new for South Africa. It resulted in a policy document of five or six pages that all three metropolitan councils had bought into, which was then used to seek funding for further assessments.”

On the basis of this document, the provincial transport department secured 20M rand (£2M) of funding to find weaknesses in the existing infrastructure. For instance, Park Station in the heart of Johannesburg no longer operates in a way that can guarantee passenger safety or security. This problem was compounded by the mass of illegal traders who flood into the station with huge amounts of baggage, full of wares to sell. To deal with this, Arup had to think like an economist to solve the client’s problem.

“You cannot eliminate these traders because they are important to the local economy,” says Leszek. “So, the question we ask is how can we create a station which is a meaningful space for them? We have been working on a design to provide huge amounts of self-storage and small business units to accommodate these informal traders. In effect the station will double as a commercial centre.”

Sharing knowledge on a wider, national scale

The team from Arup is currently visiting interchanges that have been identified as problem areas. Each time Arup is accompanied by a local transport official who can then go to other stations in their locale and make similar assessments – down to the smallest bus stop.

On a national scale, other provinces have also shown an interest in using Arup’s policy document for other projects, including the regeneration of the Cape Town station in time for the 2010 World Cup. This has directly led to the Western Cape Director General for Transport, Public Works and Highways asking the Arup team to suggest how its experience can be applied to all stations in the region. »



Top: Arup proposed multi-modal facilities.

Above: Design enhancements proposed for interchanges.

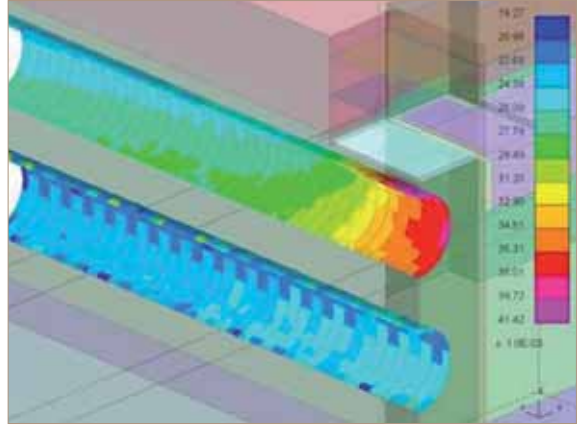
“As the experience of Arup was shared, the role of stations to integrate the Gauteng railway with the rest of the public transport system – including pedestrians – and to spur local economic development became clear and exciting.”

Lisa Seftel, former Deputy Director for Public Transport, Gauteng





Computer modelling (right) was used to show movement in the existing tunnels and to help proposed excavation sites for the Downtown Extension (left).



Singapore Downtown Extension (DTE) Advanced Consultancy: setting new standards for underground rail design.

As a major part of the development of Singapore's infrastructure, the country's government has decided to extend the city's underground system to link Singapore's old Chinatown with the recently-completed developing Downtown Marina Bay area. Marina Bay includes a new business and financial centre, the Integrated Resorts, and this new state-of-the-art transport link is intended to encourage inward investment.

Much of the downtown area has been built on land reclaimed from the sea and the ground is soft, making tunnelling and excavation difficult. A previous tunnel collapse in a mass transit construction site left the Singapore government concerned that the contractor should only begin work in full knowledge of the risks and restraints the project would present.

Having already consulted on the original tunnel collapse investigation, Arup was chosen for the job because it was in a unique position to combine local knowledge with its broad expertise. The team drew on the experience of its risk assessment people in Australia and tunnelling contract experts from New York.

An example of how effective the marriage of local and global knowledge is can be seen in the assessment of the ground movement, caused by the tunnelling on historic buildings along the line's route. By using methods employed on the London Underground Jubilee Line extension, combined with local geotechnical knowledge, the team from Arup was able to undertake a detailed analysis of these buildings to assess their structural adequacy.

Main image: The transport infrastructure in South Africa is set to play a major part in the country's future success.

Arup was chosen for the job because it was in a unique position to combine local knowledge with its broad experience.

Creating bespoke computer programs for specific problems.

Because every project is different, Arup has its own in-house software development company called Oasys, which can create bespoke programs, or adapt existing ones, to address specific problems presented.

For the overall geotechnical analysis of the Singapore DTE, Arup used a program called Oasys SAFE, which had been previously used on high profile projects such as the Kowloon Station development in Hong Kong and the Kings Cross underground station redevelopment in London.

Another program was used to help identify a feasible construction method for part of the line, which had to pass only one metre above an existing tunnel – one of the closest clearances in the world.

"If you remove the soil above an existing tunnel and therefore the pressure it provides, the tunnel will be squeezed from the sides, causing spoiling and possible damage to the tunnel," explains Arup engineer Jack Yiu. "To maintain the necessary overburden pressure we used our program to develop some innovative schemes, like installing horizontal pipes along the existing tunnel to control its movement during construction." »



The Downtown Extension will play a major part in connecting the traditional parts of Singapore with the new business district.

- Length: 3.4km
- Number of stations: 5
- Estimated cost: SGD\$1.4BN
- Timescale: 5 years – completion planned for 2012

Singapore DTE

Understanding a problem well – propose a better solution.

The DTE project is full of examples where added value and innovation have been included. For example, in some areas where a trench has been dug and the rail tunnel laid at the bottom of it, the common practice of filling in the remaining space was avoided, as the team had a better idea.

An air-conditioned commercial and pedestrian area was added below street level. It acts as an extended entrance to the subway as well as a pleasant thoroughfare for pedestrians, the DTE becomes attractive to use, and local communities benefit from less foot traffic.

This social approach – rather than one focused simply on the engineering objectives at hand – results in a more rounded, usable project. This means that the benefits stretch beyond the confines of the project itself, delivering added value to the entire region. □

The Life Cycle concept

The building life cycle concept attempts to account for every aspect of a building's life, in three phases.

1. The production phase

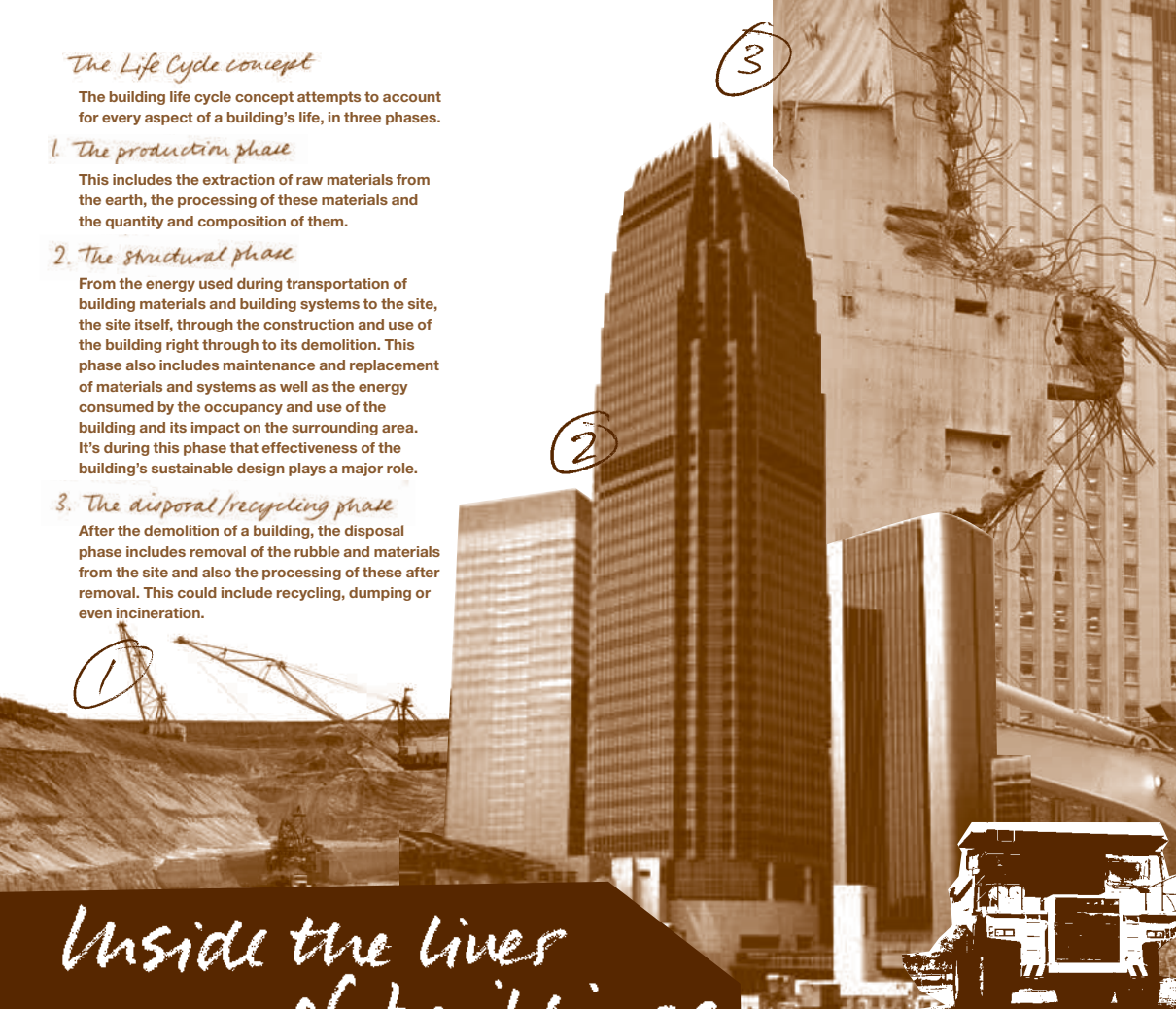
This includes the extraction of raw materials from the earth, the processing of these materials and the quantity and composition of them.

2. The structural phase

From the energy used during transportation of building materials and building systems to the site, the site itself, through the construction and use of the building right through to its demolition. This phase also includes maintenance and replacement of materials and systems as well as the energy consumed by the occupancy and use of the building and its impact on the surrounding area. It's during this phase that effectiveness of the building's sustainable design plays a major role.

3. The disposal/recycling phase

After the demolition of a building, the disposal phase includes removal of the rubble and materials from the site and also the processing of these after removal. This could include recycling, dumping or even incineration.



Inside the lives of buildings

Measuring the environmental impact and cost of a building through its life requires specialist knowledge and specialist tools.

➤ There's more pressure than ever to produce buildings that have minimal environmental and financial impact throughout their lives, and developers are being expected by the tenants or building owners to consider this in their construction plan. But it is a complex task, particularly in Hong Kong where, until recently, there were no tools to enable this practice.

That was until the Hong Kong Government's Electrical and Mechanical Services Department approached Arup to develop a piece of software that would enable developers and designers to carry out thorough Life Cycle Assessment (LCA) and Life Cycle Cost (LCC) studies.

By carrying out in-depth analysis of 28 high-rise office buildings, hotels and shopping

centres, the Arup team was able to create a database of materials and service systems commonly used in Hong Kong. This database, and the Life Cycle Inventory data it contains, can be added to and adjusted when it is deemed necessary, allowing designers and developers to set targets and implement design improvements to their buildings before construction has even begun.

The Arup team also developed a computational model to predict the operating

energy usage of a building. This added functionality results in an accurate analysis of the impact a particular building will have on the environment, the client's budget and on capital and operational cost.

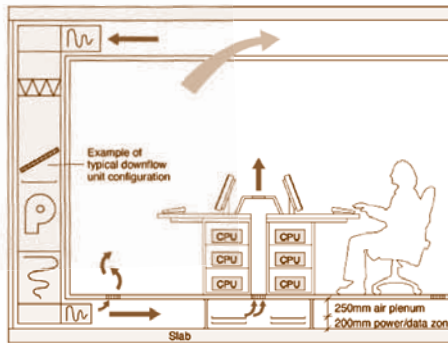
This Green Building award-winning LCA/LCC computer software has become a key part of sustainable assessment in Hong Kong, with flexible modules that can be applied internationally. □



New York Power Authority
The New York Power Authority (NYPA) is a state agency focused on economic development and power delivery. It approached Arup with a new objective: to be the greenest utility in the US. Arup's consulting teams in San Francisco and New York have been developing a sustainability plan that includes a series of strategies to achieve this. Remarkably, carbon neutrality may not necessarily be a primary

goal. "In some situations closing down or offloading carbon-emitting sites means that you simply lose capacity, without achieving significant sustainable advantages," explains Fiona Cousins, project director. "We have to be careful to balance moves towards carbon neutrality with sustained performance levels and a sustainable business practice that makes a real difference."

At the end of the consulting process NYPA will have a wide-ranging and effective plan and the skills, confidence and relationships to ensure continued improvements going forward.



Left: Ventilation at BP's new building has been designed for optimum performance.

Building legacies

The theory and practice behind sustainable development often adds value beyond the finished product. It's a classic example of the whole being greater than the sum of its parts. Three examples of the value that is created beyond the sustainability projects tell the tale.

BP's Westlake Campus

On the quest for more sustainable business practices, BP is an acknowledged global leader. But rolling out such sweeping change presents its fair share of challenges. For its Westlake campus in Houston, BP consulted Arup for engineering advice on how to reduce the carbon footprint of its facilities there. Longer term, it wanted a strategy to take its carbon-neutral goals to the next level.

Developing a new building at Westlake campus to meet the LEED™ (Leadership in Energy and Environmental Design) Platinum standard, marked a new phase in the company's commitment to sustainable business. All environmental aspects of the design, which includes a parking garage, trading floors and office space to house BP's Integrated Supply & Trading team, are fully integrated and used to their maximum benefit.

The project requires space for 800 traders and 1180 other staff. It is a highly visible demonstration of BP's focus on achieving best practice at a particularly appropriate time.



"A sustainable business practice that makes a real difference"

Fiona Cousins, Arup

Kresge Foundation Headquarters

The Kresge Foundation seeks to support other non-profit organisations that advance the well-being of humankind. In achieving the very highest levels of sustainability, its new headquarters helps the Foundation to continue its overall mission, while attaining its environmental goals.

As the mechanical, electrical, plumbing and fire protection engineers, Arup's team developed an integrated design that helped the Foundation to achieve its goal to 'build green'.

Features of the design

- 1 The building uses high-performance glazing, and the walls and roof have double the insulating performance of a typical building.
- 2 More than half of the building's north-south façade is made of glass, compared with just over a quarter for its east-west façade. Strategically managing the entrance of light helps to regulate the building's heating and cooling load.
- 3 Operable window shades and light shelves block out solar heat when needed, while providing natural light deep within the building. Photo sensors within the space turn off the lighting when natural daylight is sufficient, saving electricity.
- 4 The parking area is covered with pervious pavers resting on layers of crushed rock. In addition to controlling and filtering the storm water runoff, it protects a series of underground pipes that plunge 122m vertically and is used to heat and cool the building without the use of site-consumed fossil fuels.

Rainwater harvesting is just one of the environmentally friendly cost and resource saving techniques employed at the California Academy of Sciences.

Saving for a rainy day

Water shortages are emerging as a problem in many parts of the world. What better way of tackling this than by harvesting rainwater for practical use?

➤ Arup's rainwater harvesting tool is available to its engineers around the world via the web.

The tool asks for information such as the proposed occupancy of a building, the roof area, estimated water use per person and so on. Regional rainfall data is contained within a database (or can be procured as needed), so the designer clicks on the town nearest to the project's location.

The tool then calculates the savings that will be achieved, both as a percentage of water costs and in cubic metres of water saved. The capital outlay of the tanks and other rainwater harvesting equipment are all taken into account. How long the equipment will take to pay for itself is also calculated.

The tool provides a quick and easy way for the designer to assess the potential for rainwater harvesting and make recommendations to the client on that basis.

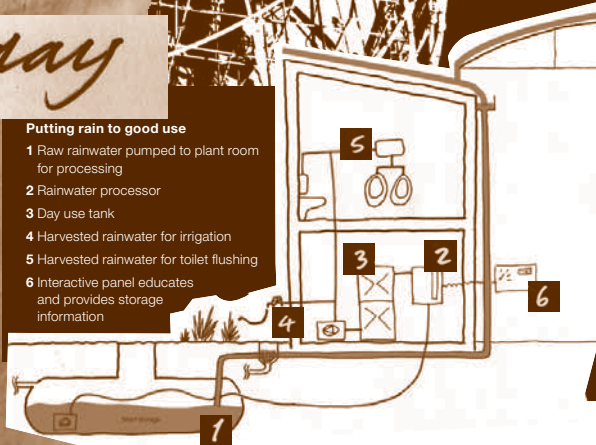
An early version of the rainwater harvesting tool was used at the UK's Eden Project in Cornwall – a contemporary tropical plant house – where a series of channels, tanks and treatment facilities allow rainwater to be collected and reused for humidification of the plant houses.

The experience that Arup gained on the Eden Project informed the subsequent ongoing development of the design tool.

This online tool, unique to Arup, is more and more frequently being put to use as clients increasingly demand environmental sustainability. □

Putting rain to good use

- 1 Raw rainwater pumped to plant room for processing
- 2 Rainwater processor
- 3 Day use tank
- 4 Harvested rainwater for irrigation
- 5 Harvested rainwater for toilet flushing
- 6 Interactive panel educates and provides storage information



The tool also has many other features. For instance, by analysing daily rainfall data it allows designers and engineers to optimise water tank size to give the best 'payback period', to create maximum storage data or to provide drought cover anywhere in the world. It also assesses long-term maintenance costs against Sewerage and water charges, and could aid the designer to achieve excellent BREEM™ or SPeA™ ratings.



Specially converted buses will run partly on existing roads, but mainly on the new busway, designed to move people away from other transport routes.



For the record

The UK's Cambridgeshire County Council is taking action to persuade thousands of drivers to get out of their cars and onto a sustainable transport system – and they've created the world's longest guided busway in the process.

➤ Large numbers of people travel daily between Huntingdon, St Ives, Cambridge and the villages lying between them on a busy and overcrowded trunk road. The county council has decided to build the world's longest guided busway to encourage drivers out of their cars, and has asked Arup to design it. Using a disused railway corridor for much of its length, and making best use of park and ride facilities, this bus-only transport system will stretch for 25km – creating the longest guided busway in the world.

In the 15 years since the railway was closed, the trackbed and surrounding areas have developed into habitats supporting a wide range of plants and animals. Arup's challenge was to show sensitivity to this environment, while creating a route for frequent, reliable bus services that would give genuine benefits to the surrounding communities. The resulting project is a working example of green transport principles.

First, the ballast on the trackbed – which contains a rich bank of seeds of local flora – is being reused in other places, including the roof of the depot building at the St Ives park and ride, where it will offer a safe haven

for wildlife. Reusing materials in this way is extremely cost effective.

The route consists of two parallel 'guideways', for guided busway services. Adjacent to the guideways is a maintenance track, providing access for planned maintenance and emergency vehicles. The maintenance track is also to be used as a route for equestrians, cyclists and pedestrians. Ballast will be reused between the guideways: a green solution that allows the local ecology to remain in place and means that less construction material needs to be transported to the site.

The council has also asked Arup to design 16 areas of natural habitats along the route to encourage biodiversity. These sites, covering a total area of 15ha, include woodland, meadow and wetland, and will mean that overall, more habitats are created than are affected by the project.

Understanding local concerns has resulted in a project with significant transport benefits for bus users, cyclists and pedestrians, through a design philosophy underpinned by environmental responsibility. □

Natural defence

The new RAAF HQ in Richmond sets the standard for sustainable design in Australia – what makes it particularly special is a lot of hot air.

➤ To support the Australian Defence Force's ability to defend the country and its national interests, Australia's Department of Defence is currently working to become a leader in sustainable environmental management. Substantial funds have already been committed to Environmentally Sustainable Design (ESD) and the Richmond 36/37 Squadron Headquarters, part of the RAAF Richmond Reinvestment Project, is Australia's first Green Star development.

The original RAAF Base Richmond site was the first air force base to be established in New South Wales, and the second within Australia. Its rich military history has seen notables such as Sir Charles Kingsford-Smith landing the Southern Cross there after his trans-Pacific flight in 1928, followed some seven years later by Miss Jean Batten, after her solo flight from England.

Formerly a base of major importance in Australia's defence, it has since evolved from a combat centre to become the home of most of the Air Force's air transport fleet. The new Richmond HQ, home to approximately 100 employees, is a significant project in its own right, and will play a large part in informing Defence's approach to ESD on future projects.

As the ESD consultants for this project, Arup's teams were responsible for forming the design concept and performing energy and daylight modelling.

"What was key for this project, though, was the ability to use natural ventilation and air conditioning through automated mechanical control dampers and a thermal chimney," explains Haico Schepers, Arup's project director for the new HQ.

The building uses secure ventilation openings on the floorplate to allow fresh air into the office when outside conditions are comfortable. This is typically 50% of the time. The chimney helps to pull the air evenly across the floorplate and as it heats up automatically pulls more air through to enhance the cooling effect.

All of the solutions implemented were designed to maintain the operational integrity of the building, while increasing the quality of the indoor environment. Arup

"What was key was the ability to use natural ventilation and air conditioning."

Haico Schepers, Arup

used mixed-mode natural ventilation and active chilled beam technology, which reduced energy consumption by half compared to a conventional building. The space also makes best use of natural daylight, minimising the need for artificial sources.

Although the rural location of the site limited the provision of public transport options, Arup looked to make impacts in other areas of sustainability to achieve a 5 Green Star rating. Water efficiency was one such area, where a 100% Green Star category score has been achieved, thanks to the installation of a range of conservation measures from the standard water efficient fixtures and fittings and rainwater harvesting, to the more unusual waterless urinals and drought-tolerant landscaping requiring no irrigation. Consequently, the RAAF HQ uses approximately 50% less potable water than similar new defence buildings.

The building has already received two sustainability awards and its success means that the one thing RAAF Richmond definitely will not need to defend is its new HQ's environmental credentials. □

Awards

- Royal Australian Institute of Architects Award for ESD and Energy Efficiency, 2006
- Royal Australian Institute of Architects Sulman Award, 2006

© Brett Boardman Photography





Project notes

- Under-slab natural ventilation culverts, hollow core Indoor Environment Quality slabs and automated louvres improve natural ventilation. Indoor air quality is improved through the use of paint, carpet and composite wood products that give off less gas than conventional products.
- All sewage is treated by the site's wastewater treatment plant and reused for irrigation on RAAF Base.
- RAAF Richmond's design performs more than 20% above the 5 Star ABGR benchmark.
- With a 5 Star Green Star rating for as-built and interiors certification, the Richmond 36/37 Squadron Headquarters is the first project to achieve Green Star Certified Ratings for both Office Design and Office as Built.



Finding a firm footing

Hong Kong's mountainous terrain is vulnerable to landslides – understanding and controlling slope movement is crucial to safety.

➤ A landslide is a geological phenomenon resulting in a wide range of ground movement, such as rock falls, deep failure of slopes and shallow debris flows. Although gravity acting on an over-steepened slope is the primary reason for a landslide, there are other contributing factors affecting slope stability, such as weather conditions and human causes including mining and logging.

Hong Kong is one of the most densely populated cities in the world. Its dense urban area is surrounded by steep hills and this, combined with its climate and soil structures, makes the city particularly prone to landslides. The lack of space compounds the problem, and there are constant alterations to the landscape. All this means that not only is the risk from a landslide onto Hong Kong's dense urban area extremely high, the impact of such an event on human lives and infrastructure could be devastating.

In 2005 Arup was asked by the Hong Kong Government's Geotechnical Engineering Office (GEO) to investigate four landslide-prone areas of natural terrain. The GEO needed to know, in real time, if there was slope movement and, if so, how much. The firm's team of engineering geologists and geotechnical engineers carried out detailed field mapping and ground investigation, reviewing all the types of instrumentation available to determine the most appropriate strategy for each site in the process.

Prevention and mitigation

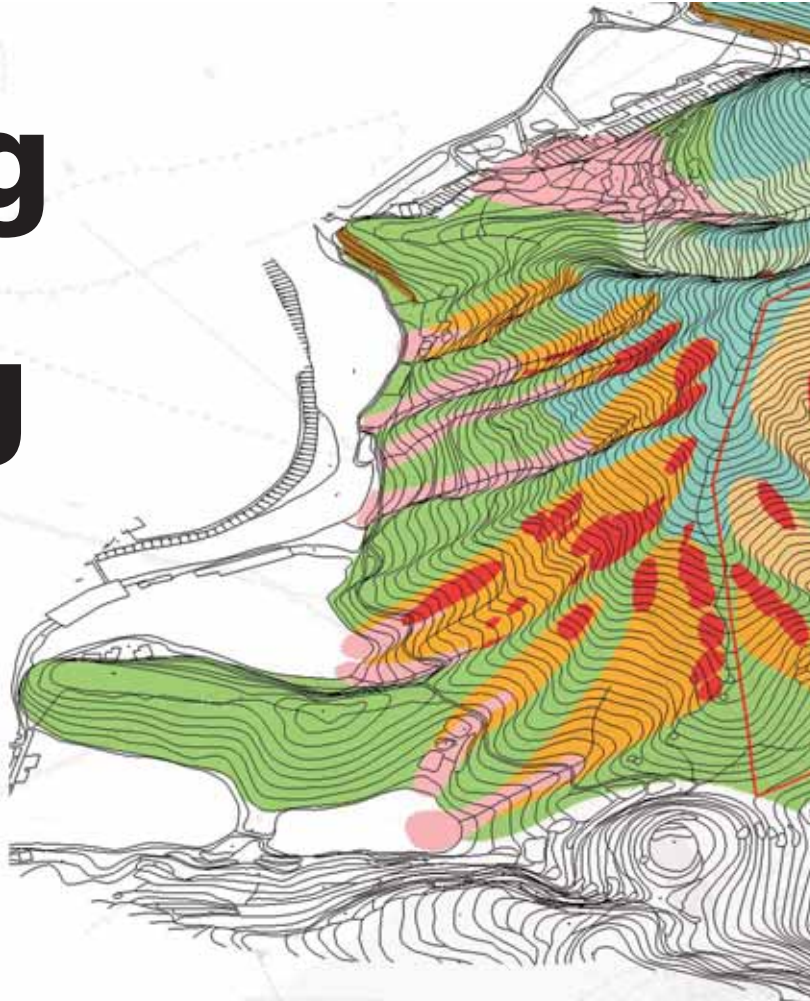
Where landslides have already been identified as a hazard, measures need to be taken to mitigate the risk. Three such sites in Hong Kong (Kwai Chung, Victoria Road and Luk Keng village) have already been targeted. A preferred solution is to use concrete barriers to constrain landslide debris. Given the large site areas, this is more practical than trying to stabilise all potential sources of landslide. Landslides are allowed to occur, but the debris is contained.

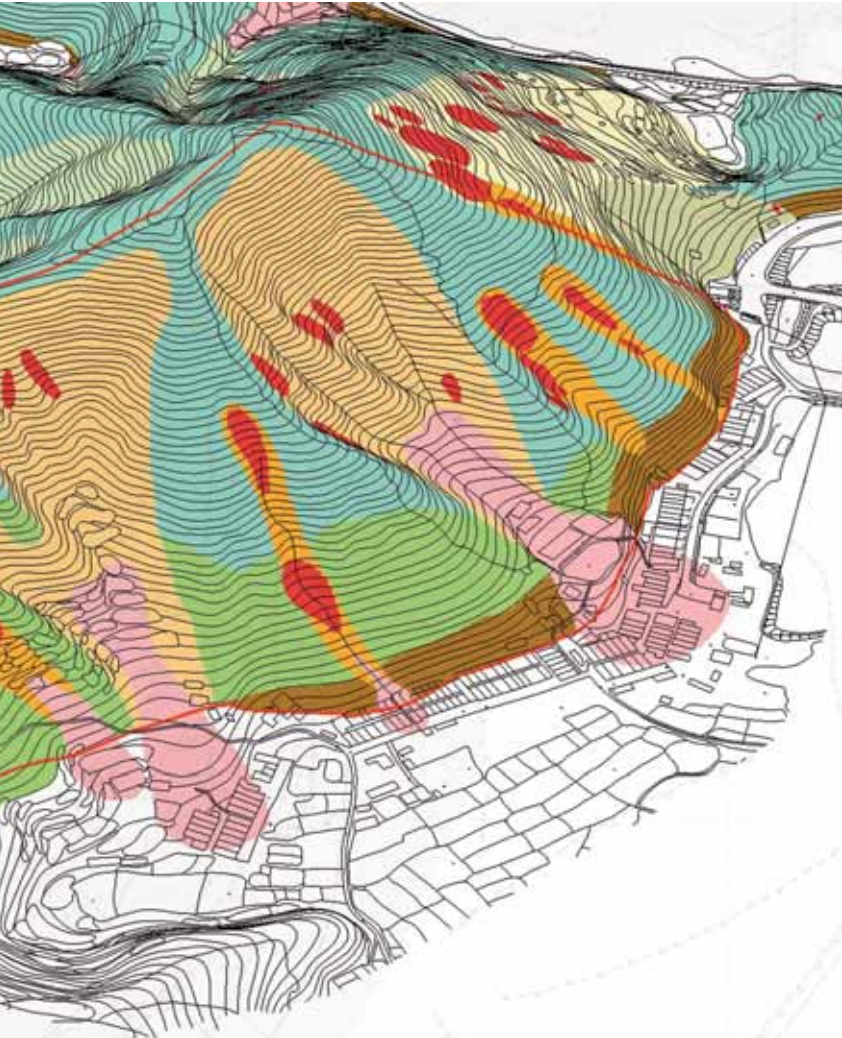
Tensioned steel-mesh fences are another, more versatile option: they are easier to install in steep areas and are less visually intrusive, as vegetation can grow up them. They are particularly useful in countering rockfall hazards.

Another widely used technique, intended for soil stabilisation, is 'soil nailing'. It's a preventative method

that works by reinforcing a slope so that landslides don't occur in the first place. Long, closely spaced nails, made of unstressed steel bars, are grouted into drill holes on the slope face. Extending beyond the depth of the potential landslide surface, the nails create a reinforced section that is stable and able to retain the ground behind it.

Arup works with nature rather than against it, where possible. Improving drainage, for example, minimises the impact of heavy rainfall in the wet season. Bioengineering – where trees and vegetation with dense root networks are planted – also helps stabilise the slopes. Whatever the risks, the solutions are always carefully tailored to individual site conditions. □





Geofibre

Arup's involvement in landslide prevention extends to the use of an innovative 'greening' technology, Geofibre. This is a medium in which plants can grow that can be sprayed to hard, steep, almost vertical slopes and reuses old building materials for its sandy layer.

The plants bind together the underlying surface with their roots and provide an attractive natural habitat for more plants and animals. Slope greening is popular with clients and the public, and Geofibre is more flexible than traditional greening technologies.

Words: Betzy Dinesen



To monitor slope movement, Arup has developed a fully automated system for collecting and reporting data. The instruments collect readings every minute and upload them to a secure internet site, so the data can be checked in real time. If movement is detected, the system will trigger a warning email or text message/SMS to the engineer responsible and precautions can be taken. New or rarely-used instrumentation techniques have also been introduced, including 'time domain reflectometry' – a cost effective approach for a large number of slopes that is being trialled alongside conventional methods.

Key (study area within red line)

- Shallow, recent and existing landslides.
- Retrogressive basin with repeated and recent shallow landslides.
- Degraded basin with occasional recent shallow landslides.
- Drainage basin with few shallow landslides.
- Over-steepened slope at toe of hillside with occasional recent shallow landslides.
- Debris fan.
- Slopes with open hillslope colluvium overlying saprolite derived from mudstones. Few landslides.
- Slopes with open hillslope colluvium overlying saprolite derived from compressed volcanic ash, sandstone and siltstones. Few landslides.
- Saprolite derived from compressed volcanic ash, sandstone and siltstone. Minor surface erosion.

Client: Hong Kong Geotechnical Engineering Office

Treasure Island facts:

- 182ha
- 6000 residential units
- 90-100 dwelling units per net residential acre
- 90% of all residential and commercial activity within a 15-minute walk of a transit hub
- 50% of island will be open space

➤ Treasure Island in San Francisco Bay is being transformed from a decommissioned naval station into a community where 20 000 people will be able to live energy-efficient lives. To deliver this far-reaching sustainable redevelopment, Treasure Island Community Development (TICD), a consortium of developers including Lennar, Wilson, Meany & Sullivan, and Kenwood Investments, is working with a host of city, county and state authorities, including the San Francisco Department of the Environment, the Public Utilities Commission, the Mayor's Office of Emergency Services and the Bay Area Water Transit Authority.

Arup is advising TICD on transportation planning, site infrastructure and sustainability strategies for the 6000-unit residential and mixed-use development, that will draw more than half of its energy from renewable sources. The scale of this project makes it a flagship development that is attracting interest from all over the world. Its success depends on a realistic, measured approach.

"To be viable, the project needs to attain a certain threshold of people to move to the island, and a level of density that can sustain the kinds of services and values that we believe in," says Jared Blumenfeld, director of the San Francisco Department of the Environment. Arup's work has focused on these objectives, and the resulting sustainability programme for the redevelopment of Treasure Island and neighbouring Yerba Buena Island outlines the plans for this new urban neighbourhood, incorporating best practices in smart urban design, low-impact development and green building. The 182ha site will be transformed into a vibrant, liveable community and regional attraction, where walking and cycling will be the prevailing means of transportation.

Acres of previously unusable land will be turned into fields and parks for the enjoyment of local residents and island visitors. Street grids and buildings have been positioned to make best use of available sunlight and for maximum wind protection. The rotated grid will provide residents with a more comfortable outdoor environment that can be enjoyed for a greater portion of the year.

Paying close attention to the island's weather and climate also contributes to greater energy efficiency. Plans for rooftop photovoltaics, which would make the project a net exporter of renewable energy during peak solar hours, will reduce per capita CO₂ emissions by 60%.

Transport access is critical to the community's success, and a comprehensive transit programme has been developed to provide residents, visitors and employees of the two islands with convenient, clean transit, readily accessible from anywhere. Options will include a regular ferry service to San Francisco and other Bay Area cities. Other plans call for hundreds of homes to be within a 15-minute walk of a transit hub and commercial centre. □

21st century alchemy

From brownfield to urban living,
San Francisco's Treasure Island is a
model of sustainable development.

Tokyo Designer's Week

Arup was selected by Icon Magazine and the Design Association, Tokyo, to exhibit at the international Container Exhibition of the 2006 Tokyo Designer's Week. Arup designers Tristan Simmonds and Jennifer Greitschus, in collaboration with Teppei Ishibashi of Arup's Tokyo office, transformed a shipping container into a sushi bar with a twist – a postcard bar. Entitled 'Envois', their design – sponsored by Alex Engineering, Xela Corporation, Targetti, Tony Corporation, and Takiron – presented 'food for thought' from the Drivers of Change 2006 card set.

Working with a team of students from Nihon University, with digitally controlled lighting designed by Arup's Francesco Anselmo, the container was transformed into an evocative space bathed in red and pink. Postcards bearing messages in English and Japanese rotated around the bar and visitors sat on specially-designed heart-shaped stools and picked postcards that appealed to them. They were also given the opportunity to write their own postcard – perhaps a letter to the world, a note to a friend or their own thoughts about the future.



In the driving seat

Arup examines the forces that will shape the world of tomorrow.

Arup is undertaking a global research programme examining the issues that will have the greatest impact on human development over the next century. The research, led by Arup's Foresight, Innovation & Incubation Group, is known as the Drivers of Change. It examines the most pressing global trends affecting our world. These issues were identified in a series of external workshops with clients and other influencers. Out of a longlist of significant topics, three were identified as the first to be explored in depth: energy, climate change and water.

Each of these priority areas is being researched by an Arup practitioner with an interest in the field. As each topic holds its own significance to different regions of the world, cross-region debates have taken place to identify how these major subjects will affect the work and business of Arup, giving the research a very practical focus. This understanding sharpens Arup's keen strategic planning abilities, enabling it to become a leader in this area.

One of the project's outputs – for use within and beyond the firm – has been to condense the research into sets of flash cards that pinpoint facts and questions to spark further debate.

This whole research process has been made possible by Arup's unique ownership, culture and resource-base. The firm is owned in trust on behalf of its employees, which allows it to invest in its long-term interests in a way that organisations with external shareholders might find hard to justify. Arup's culture also positively encourages its people to indulge their curiosity and to continue learning. This, together with the company's diversity of location, discipline and demography, brings a great richness to the debates and the research. □

Words: Sarah Foberis

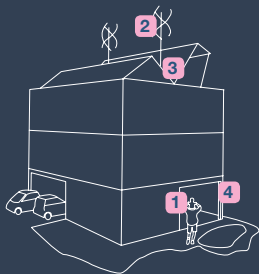
Client: Arup

Worldwide
Drivers of Change/Tokyo Designer's Week

Climate culture

As the world changes, so will the demands on our housing.

Whatever your view of environmental change, one thing we can all agree on is that the effects of this phenomenon will affect the way we design and use houses. Keen to understand how environmental, energy-source and social changes would impact how we use our homes, financial services provider Zurich commissioned Arup's architectural practice, Arup Associates, to consider the possible changes in home use in the UK over the next 75 years. With the knowledge gained from Arup's Drivers of Change research, a fascinating yet realistic view of the future was delivered. □



The study revealed a series of key areas that the designers and insurers felt would be significant:

1 Social developments

Demographic changes suggest longer lives and smaller families. Property may need to adapt to how households change over years, perhaps with three or four generations of a family living together, though independently. Technology may allow people to work increasingly from home – and this might create stronger communities again, as people crave human contact to counter the solitude of home working.

2 Energy self sufficiency

Could solar panels, domestic wind turbines, triple-glazing and intelligent insulation (that adjusts to the external temperature) become standard features? And if our homes can generate enough power for their own needs, might the excess energy be used to run our cars?

3 No waste water

Saving water will become a priority and our homes will need to capture, re-use and recycle water wherever possible. Gathering and harvesting rainwater could be made more efficient by using an inverted pitched roof as a giant funnel.

4 Going with the flow

As the weather becomes more extreme, our property needs to be better able to resist storms and floods. Houses on stilts above flood plains may become commonplace.

Though currently little used, many of the technological changes and advances that we might need to combat our changing environment are available to us now. The developments are likely to see the technology become more accessible and affordable as it becomes more commonplace. And perhaps as our homes become more sophisticated, we will also see the end of the do-it-yourself trend that has been a growing cultural shift since the 1970s.

ARUP'S PEOPLE
DISPLAY A GENUINE
INTEREST AND
ENTHUSIASM
FOR FINDING
NEW WAYS
TO APPROACH
PROBLEMS

David Murchland, Brisbane

AS A COMPANY
WE ALWAYS
STRIVE TO IMPROVE
AND PUSH THE
BOUNDARIES,
PARTICULARLY WITH
GREEN ISSUES

Morwenna Wilson, London

THE ARUP PROCESS
WAS VERY
INTERACTIVE
AND CONSULTATIVE,
WITH ALL
STAKEHOLDERS
ABLE TO MAKE THEIR
CONTRIBUTION
AND DEBATE THE
VISION
OF THE PROJECT

Lisa Seftel,
Gauteng Stations Precinct Initiative

AFTER THIRTY YEARS
IN THIS INDUSTRY,
WHAT EXCITES ME MOST
IS THE FACT THAT I'M GETTING TO USE
CUTTING EDGE
TECHNOLOGIES THAT I'VE NEVER USED BEFORE

Kathy Noonan, Boston

THE BIGGEST
REWARD
COMES AT THE END
OF A PROJECT
WHEN YOU CAN
STAND BACK AND SAY
"I WAS A PART OF THAT"

Malcolm Barr, Boston

NO MATTER WHAT THE QUESTION,
THERE IS SOMEONE IN ARUP
WHO EITHER HAS THE ANSWER
OR WILL WORK WITH YOU TO
FIND A SOLUTION

Shirley Brooks, London

UNO SE PUEDE CONSIDERAR UN
EXPERTO
EN SU CAMPO,
HASTA QUE UNA NUEVA INFORMACIÓN
DE OTRA DISCIPLINA MODIFICA
NUESTRAS IDEAS
PREESTABLECIDAS,
Y TENEMOS QUE VOLVER A FIJAR
LOS FUNDAMENTOS.
CUANDO SO SE PRODUCE, ES UN
GOZO INTELLECTUAL
PARA NOSOTROS EN ARUP

Ignacio Fernández, Madrid

HERE AT ARUP THE
POSSIBILITIES ARE
ENDLESS
AND SO IS THE
RANGE OF
SKILLS
THAT I'M CONTINUALLY
GAINING

Easi Arisan Winthia, Singapore

ER IS GEEN MAGISCH OF GEHEIM RECEPT,
PASSIE VOOR ONS VAK ONDERSCHIED
ONS VAN DE CONCURENTIE

Joop Paul, Amsterdam

WE ARE VERY PLEASED WITH
ARUP'S ABILITY
TO WORK CLOSELY
WITH AUTHORITIES TO REVIEW
DIFFERENT ALTERNATIVES
AND DEVELOP
INNOVATIVE
AND FINANCIALLY ECONOMICAL
SOLUTIONS

Kuok Khoo Tsen, Kerry Properties Limited

若追求卓越是
我翱翔天際的動
力,奧雅納是承
托我身軀的風

Goman Ho, Beijing

ARUP IS CHALLENGING,
ADAPTABLE, CREATIVE AND
CLIENT FOCUSED

Ryan Biziorek, New York

Published on behalf of Arup by Tileywoodman,
West House, 20 West Street, Reigate, Surrey, RH2 9BS.

Printing: Gemini Press. Printed on totally chlorine-free paper,
which has an internationally recognised manufacturing and forestry
management quality assurance. The book is fully recyclable.

www.arup.com

© Arup 2007. All rights reserved. Reproduction in whole
or part prohibited without prior permission.

ISBN: 978-0-9516602-9-4

