

An aerial night photograph of a city, likely San Francisco, showing a dense urban landscape with numerous lights from buildings and streets. The city is situated on a hillside overlooking a body of water, with the lights reflecting on the water's surface. The overall scene is illuminated in shades of blue and white, creating a vibrant, high-contrast image.

A2

NEW DIMENSIONS FROM ARUP | NO.7

WHERE NOW FOR CITIES?

CLIMATE CHANGE ACTION PLANNING | INTERVIEW: MAYOR DAVID MILLER
THE LEGACY OF LEISURE | HIGH PERFORMING PROPERTIES | PROTECTING
CITIES | PEOPLE AND CITY LIFE | FUTURE CITIES

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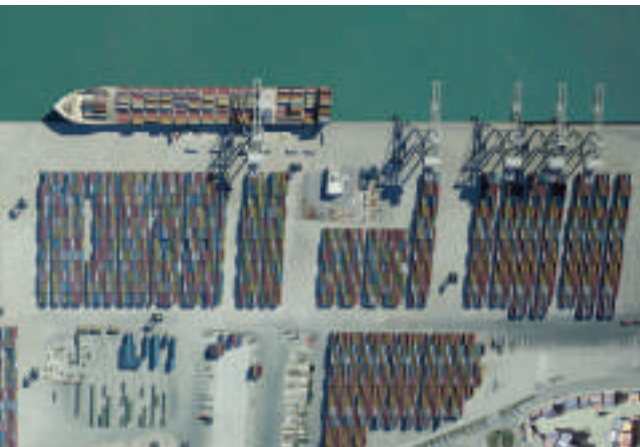
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WELCOME TO A², THE BUSINESS MAGAZINE FROM ARUP

“The growth of cities will be the single largest influence on development in the 21st century.”

United Nations, State of World Population 2007

In 2008, the proportion of the world’s population living in an urban environment surpassed 50% (some 3.2bn people), and it is expected that by 2050, approximately 70% of the global population (6.3bn people) will be living in cities. In China alone, the urban population is set to reach 1.12bn by that date – a transition of over 600m people from rural to urban, representing the largest shift in humanity ever witnessed.

Urbanisation and climate change, both driven by population growth, represent the greatest challenges facing mankind in the 21st century. And, in the context of this eco-challenge, economies around the world are threatened by one of the deepest recessions since the Great Depression.

While national and international organisations, such as COP15, set the strategic response to these global challenges; it is cities, with their concentration of citizens and capital, their proximity to the people and issues, and their manageable political scale, that hold the dynamism and influence to effect those changes quickly on the ground.

So, cities have a pivotal role to play in effecting the local response to these global challenges, but cities themselves are not easy to change. Complex organisms made up of systems within systems, they have developed organically over time and are constantly evolving in the response to a rapidly changing environment. Therefore, a new and holistic approach must be taken to development going forward.

Through a series of feature articles, this edition of A² hears from industry experts on how to undertake an integrated

“It is cities, with their concentration of citizens and capital, their proximity to the people and issues, and their manageable political scale, that hold the dynamism and influence to effect those changes quickly on the ground.”

response to some of the challenges facing the urban environment. From an interview with Mayor Miller on his aspirations for Toronto and the C40 cities group, to a practical approach to climate change action planning, and inspiring grass roots change amongst citizens, we explore the metropolitan green agenda.

Having seen a fall in the property market in many parts of the world, we also hear how sustainable property portfolios can deliver on the bottom line, and explore aspects of the social side to cities, such as harnessing the potential of leisure venues in fostering economic and social development, and how to manage the strategic risk and security agenda.

At Arup, we are working across the board with cities and their suppliers to develop leading edge, integrated solutions that respond to these global challenges, from top-level policy and strategy development, to practical design and delivery of infrastructure. Arup is one of the few organisations in the world with the breadth and depth of skills and understanding required to make a real difference in cities today and into the future.

I hope you enjoy this edition of A². If you would like to discuss any of the issues covered in this magazine, please do not hesitate to contact us at a2@arup.com

**Alan Belfield, Chair,
Global Consulting.**

News

FIRST C40/ARUP WORKSHOP HELD IN TORONTO, CANADA

Pioneering approach to setting the city's energy strategy

The C40 is a group of 40 of the world's largest cities, committed to tackling climate change. In May 2009 Arup, the C40 and the Clinton Climate Initiative (CCI), a project of the William J. Clinton Foundation, signed a Memorandum of Understanding (MoU) agreeing Arup's support in helping the world's largest cities to tackle climate change.

Using its 'Sustainable Integrated Development' approach – which addresses the interdependency of land use, energy, waste, water, transport, agriculture, economics and sociology – Arup is delivering action-orientated workshops aimed at developing each city's carbon reduction programmes. Arup is also offering ongoing strategic and technical advice to the C40 and is supporting the CCI's Climate Positive Development programme.

Following the MoU signing, September saw the first of the C40/Arup UrbanLife workshops take place in Toronto. Hosted by

the Mayor of Toronto and Arup, senior city officials, utility companies and city residents joined energy experts to devise a plan that will allow Toronto neighbourhoods to enjoy a higher quality of living, with an 80% reduction in carbon emissions.

Focused initially on one neighbourhood, 'The Peanut', the workshop used Arup's carbon reduction tools and urban planning expertise to develop a methodology that can now be repeated in neighbourhoods across the city.

David Miller, Mayor of Toronto and Chair of the C40, said "We can't reach our carbon reduction goals without everyone doing their part. The C40 UrbanLife workshop was an important step towards understanding what actions different groups must take and how the benefits of acting together can be coordinated in the most effective way."

Further C40 workshops are planned for Sao Paulo, Melbourne and cities in Europe and Asia.

DESIGNING A RESILIENT HONG KONG

Presidential address by Dr Andrew Chan



Arup Group Deputy Chairman, Dr Andrew Chan, was elected President of the Hong Kong Institution of Engineers (HKIE), for the 2009/10 session in June this year, dedicated to leading the institution to new heights, especially in the context of 'leadership in sustainability'. With a total of 23,000 members, the HKIE is the second largest professional institution in Hong Kong, playing a significant role in public affairs, especially the city's infrastructure development.

In his presidential address to members, Dr Chan set out his vision of a resilient Hong Kong in response to climate, financial and environmental challenges and outlined the crucial role of engineers in realising this vision.

Chan's speech, 'Engineers: designing a resilient Hong Kong', assesses Hong Kong's current and planned infrastructure in energy and buildings, water, waste, transport and agriculture and emphasises a holistic, sustainable strategy to combat and defy its challenges.

"During the past several decades, Hong Kong has overcome many barriers and become a resilient country, with the positive capacity not just to cope, or survive but drive sustainability with strength that defies adversity. But such resilience was fortuitous. Hong Kong currently faces new and greater challenges, from climate change to economic competitiveness to infrastructure. The city now must actively design its resilience – with engineers uniquely skilled and positioned to lead the way," he said.

To watch the full address please visit http://www.arup.com/News/2009-09-September/23-09-09-Designing_resilient_Hong_Kong.aspx



1 and 2 C40/Arup UrbanLife workshop in Toronto

3 Dr Andrew Chan delivers his presidential address to members of the Hong Kong Institution of Engineers (HKIE)

FLOOD RESILIENCE

Preliminary results of Arup's research with CIRIA

The Cabinet Office (head office of the UK Government) has set up a new Natural Hazards team to develop a critical infrastructure resilience programme to reduce the disruption caused by flooding, and other natural hazards, to critical infrastructure and essential services. They recently asked Arup to present the preliminary results of our research with CIRIA (the Construction Industry Research and Information Association) into the flood resilience of the UK's critical infrastructure (CI).

Arup made three key recommendations to the Cabinet Office. Firstly, the next generation national flood map should aim to provide improved data on flood risk for use by CI operators. Secondly, that there is a need for medium and longer-term protection targets for different categories of existing CI, fully acknowledging the interdependencies between different CI systems. Finally, that the Government should aim to incentivise collaborative working within and between sectors to achieve joined-up solutions to the problem of how to ensure continuity of



essential service provision during extreme floods.

'Flood Resilience for Critical Infrastructure' – due to be published later this year – provides an overview of the current UK situation, as well as recommendations for improvements. The study has involved collaboration with numerous stakeholders in the energy, telecommunications, water and transport sectors.

5 Power station in the Yorkshire floods

6 The new food Drivers of Change cards

DRIVERS OF CHANGE

Publication of new food cards

The Global Footprint Network's 'Ecological Footprint' survey says that 55% of an individual's footprint is related to what they eat. Producing what we eat is also responsible for nearly a fifth of greenhouse gas emissions, about a fifth of US fossil fuel use, and almost three quarters of the world's freshwater use. Food is therefore central to our understanding and the creation of a sustainable future.

Published in 2009, Arup's most recent set of Drivers of Change cards examine the topic of food. Each card depicts a single driver, with a factoid and rhetorical question, backed up by a brief indication of the breadth and depth of the content. This set is the latest in the Drivers of Change programme, devised by the Foresight & Innovation team at Arup, a group tasked with exploring emerging trends and how they impact upon the business of Arup and its clients.

For more information or to purchase a set of cards, please visit www.driversofchange.com



CITY INFRASTRUCTURE

A framework for systemic action

Arup and Salford University's Centre for Sustainable Urban and Regional Futures (SURF) have researched the knowledge and capacity required for cities and city regions to develop holistic urban infrastructure.

The research has informed a five-stage framework that enables civic leaders, policy-makers, and the public and private organisations involved in the infrastructure sphere, to assess how far they have come in developing an holistic plan and how their ambitions can be realised within the context of that particular city or city region.

The work stemmed from the recognition that cities rely on their critical infrastructure, yet many of the critical networks – water, energy, waste, mobility and flood protection – are out of their direct control. These existing and often tired infrastructures need to play an additional role which contributes to cities depending on a lower carbon economy.

Outcomes the framework can inform include:

- Building the capacity to engage with infrastructure stakeholders
- Developing social visions through stakeholder participation
- Positioning the city as an active intermediary to shape investment decisions
- Establishing new capabilities to manage social and technical change
- Preparing for the future in response to climate change

The framework can be adapted to suit the specific issues of an individual city.

MAYOR DAVID MILLER

In six years as Mayor, David Miller has made Toronto a global leader in tackling climate change, leading to his election as Chair of the C40 group of the world's largest cities in 2008. Most recently he launched the 'Mayor's Tower Renewal Programme', possibly the most ambitious building retrofit programme in the world, with a target to improve the thermal efficiency of over 1,000 residential tower blocks, linked to a ground-breaking, integrated urban renewal strategy.



Toronto faces many challenges. Not least, that while electricity supplied from Canada's grid will be 86% non-fossil fuel by 2014 (principally hydro-electric and nuclear), the average Torontonian still has a bigger carbon footprint than most Europeans, and 80% higher than the Mayor's target for 2050.

A² asked Mayor Miller what's on his mind.

What are the key challenges the city of Toronto faces relating to climate change?

Toronto has set an excellent record on addressing greenhouse gas emissions, having set up the first city agency in North America to address climate change in 1993. Since then we've retrofitted over 500 city-owned buildings for improved energy efficiency, installed a deep lake water cooling system that provides cool air to over 60 high-rise commercial buildings in the downtown core, built countless partnerships and launched over 150 programmes to fight climate change.

We've cut greenhouse gas emissions from the city's own operations by over 40%, based on 1990 levels, but the city government emissions account for only 6% of the emissions city-wide. We need all residents to participate in cutting greenhouse gases or we won't reach our 80% reduction target.

Toronto is one of the most culturally diverse cities in the world. Over 180 languages are spoken here. Our city is stronger because of this diversity but it also means that when we need to effect change to address our climate change issues, we have to be creative and clear about getting our message across. Our new Live Green Toronto programme includes community workers from all backgrounds and the materials for the programme are printed in 11 different languages.

What process did you go through, both politically and bureaucratically, to make addressing climate change and sustainability a priority for the city?

In 2006, I campaigned on and received a mandate to make Toronto an even greener and cleaner city with opportunity and prosperity for all. Torontonians are environmentalists. The desire and commitment was there on the part of the residents. From an administrative perspective, we've strengthened the international Executive Environment Team that includes heads of city divisions and agencies that have an impact on the environment. We've also strengthened the Toronto Environment Office to reinforce its core business of coordinating environmental initiatives that go beyond the scope of a single division. Within the public service, coordination is a key feature for effective policy development and programme delivery.

"Nations need to engage, empower and resource their cities to make significant progress on fighting greenhouse gas emissions."

Arup has recently conducted an UrbanLife workshop with the city of Toronto, which forms part of the recent MoU the firm signed with the C40. Why did you feel it would be worthwhile for Toronto to participate in this workshop?

As I mentioned earlier, coordination and broad participation across traditional discipline boundaries are very important to our success in fighting climate change. Arup had good ideas and a practical approach to this challenge. I particularly want to acknowledge Mark Watts, Peter Head and the team for their leadership on developing the concept of the UrbanLife workshop and sharing it with the C40.

The C40 UrbanLife concept offered Toronto the opportunity to bring everyone together and look at a very important issue from the perspective of integrating the various roles and responsibilities around a shared goal. In our case, we were keen to explore how broad sustainable energy policies might be implemented at the community level.

The outcomes of the workshop are still being developed, but I do know that there was a great deal of excitement about it, and I heard from a number of participants that the organizers pushed them hard to move from general discussion to concrete proposals for action.

As Chair of the C40, what are your key goals over the coming year? What will constitute success?

The most immediate goal is to raise the profile of cities and the action they're taking on climate change at the UN climate change convention negotiations in Copenhagen this December. We're thrilled to be part of Mayor Bjerregaard's Climate Summit for Mayors that takes place on 14-17 December this year, during – but separate from – the official negotiations among nations. All eyes will be on Copenhagen then and it will be a terrific opportunity for the C40 to get out its message: nations need to engage, empower and resource their cities to make significant progress on fighting greenhouse gas emissions.

Cities are where the majority of the world's population lives and it's also where the majority of action against climate change is taking place. Most of our C40 mayors have already signed up to be in Copenhagen and it's where, as a group, we'll demonstrate 'the how' of fighting climate change.

We hope our presence in Copenhagen will send a powerful message to the negotiators about what's possible now and that we'll have a real impact so that the post-Kyoto agreement is a powerful one.



Following Copenhagen, we'll continue to push for innovation among our cities, including greater emphasis on multiplying the benefits of cutting greenhouse gases, such as job creation, economic development and community revitalisation. We'll also continue to work towards getting cities access to large international funds, such as the Clean Development Mechanism, that are currently only open to national governments.

Where do you draw inspiration from for what you are doing in Toronto and what is your advice for other city leaders wishing to emulate Toronto's success in becoming a sustainability leader?

I draw my inspiration for my sustainability work from the people of Toronto. I don't really have advice for city leaders because most of the mayors I've worked with already know: you need to have faith in the residents of your city. They are demanding that we act.

My early sustainability work as Mayor of Toronto focused on the Great Lakes issues with Mayor Daley of Chicago. A turning point

for me when I was a young boy was reading a book about the Great Lakes called "Paddle to the Sea" by Holling C. Holling. That awareness of the interconnectedness of almost everything we do was sparked for me at that moment. It's the understanding that by improving the natural environment we're also creating opportunity for the people of Toronto, as well as businesses and institutions to strengthen our economic development and address social issues. That really inspires me to continue to act and make it easier for Torontonians to take action as well.

"We hope our presence in Copenhagen will send a powerful message to the negotiators about what's possible now and that we'll have a real impact so that the post-Kyoto agreement is a powerful one."

1 Mayor David Miller talks at the recent C40/Arup workshop on energy strategy in Toronto

PLANNING FOR THE ECOLOGICAL AGE – HOW TO EVOLVE A CITY



Two and a half thousand years ago, newly elected public servants in the world's first democracy, Athens, swore an oath on taking office "to leave this city not less but greater, better, and more beautiful than it was left to us."

While the principle established by Pericles remains as valid as ever, civic leaders of the 21st century face an altogether bigger challenge – the threat of climate change means that their success will be measured not just between the day they were elected and the day they leave office, but on how their legacy affects the lives of several future generations.

On pages 25-27, Peter Head and David Singleton set out a vision of what success might look like – the cities of the 'Ecological Age'. Here Mark Watts, a former adviser to the Mayor of London who now leads Arup's engagement with the C40 group of the world's largest cities, considers the challenges and solutions facing city leaders in getting there.

A blueprint for an 'Ecological Age' city

There is, of course, no generic formula for how to convert a sprawling, polluted, congested 20th century metropolis into a clean, free-flowing, low carbon city able to survive all that the 21st century will throw at it. Every city is unique, but as the Enlightenment philosopher Hegel would have put it, they are but a unique combination of universal elements. That is, there are very few problems faced by one city that haven't already been faced, and in some cases solved, in another.

For cities in industrialised nations, the task is considerable – to reduce greenhouse gas emissions by 80% in just four decades,

while improving quality of life. And there is no time to delay, the climate is changing in response to the total quantity of emissions in the atmosphere, so we can't wait to turn off the tap in the nick of time at some notional date in the future. Emissions need to start coming down sharply straight away and then flat line.

Most of the world's leading cities have evolved over many decades (London, New York, Paris). A few have been created in a concentrated burst of growth (Sao Paulo), but almost none have been 'planned'.

But that is exactly what is needed now. If the 21st century is to be the 'Ecological Age', it will also have to be the age of municipal planning. The most successful cities in 20 or 30 years time will be those that most accurately understood the challenges of climate change and the broader issues of resource depletion, and most capably planned and delivered a sustainable model of economic growth in response.

To put it more bureaucratically, every city needs a climate change action plan. We consider below the key generic elements.

"If the 21st century is to be the 'Ecological Age', it will also have to be the age of municipal planning."

Establishing the baseline

You can only deliver against what you can measure. In relation to climate change, this means mapping the profile of current greenhouse gas emissions and measuring vulnerability to climatic change.

Pioneers such as San Francisco, Stockholm and Copenhagen did this in

1 Mark Watts, Director, Arup

2 Energy hierarchy diagram



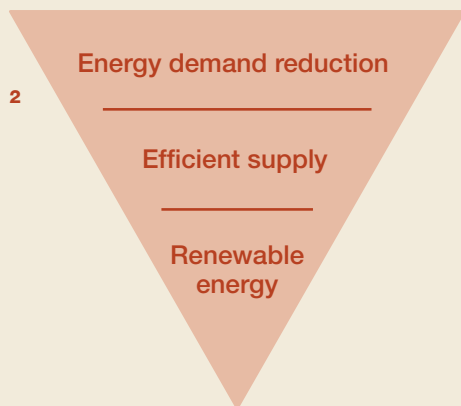
the 1990s. Many others are now following suit, and in some places are encouraged or compelled to do so by national regulations (such as 'National Indicator 186' in the UK).

To truly understand sustainability, however, one needs to go beyond a simple calculation of emissions produced within a city and measure the wider impact of consumption, from food, to water, to transport and beyond. The resulting 'ecological footprint' calculates how many planets it would take to sustain a place (or a person) if everyone adopted the same consumption patterns. The correct answer is, of course, 'one'.

Applying an energy hierarchy

Sometimes the bald emissions profile hides striking contrasts. Torontonians have an average carbon footprint that is similar to that of London, yet while London estimates that it can halve its emissions output through a national shift to renewable energy, Canada's electricity grid mix is already largely based on hydro-electricity and nuclear power.

Hence the need to build up a suite of policies using the basic principles of an energy hierarchy. This approach requires that one first considers all the opportunities to reduce demand for greenhouse gas producing energy and, second, maximises the efficiency of energy supply. This reduces residual energy demand to the lowest possible quantity – the majority of which needs to be supplied by renewable



energy, so that the desired emissions reduction can be achieved against the base case.

In practice, of course, it is not possible to work so rigidly, but the principle that one should first attempt to reduce the wasteful use of energy, before investing massive sums in generating new, renewable energy supply is crucial in determining the most efficient route to achieving the desired emissions outcome.

Reducing demand for energy

In the developed world, energy used to heat and cool buildings and power devices used within them is usually the single biggest contributor to cities' carbon emissions. And with 50-70% of existing buildings expected to still be in use in 2050, reducing energy demand by retrofitting existing stock will be a key policy instrument.

A number of cities already have aggressive building retrofit programmes in place. London mayoral adviser, Isabel Dedring, describes over-leaf a programme to cut energy used in hundreds of municipal buildings. On pages 8-9, the Mayor of Toronto sets out how he has launched perhaps the most ambitious residential retrofit programme in the world, tackling over 1,000 1960s and 1970s-built tower blocks through the 'Mayor's Tower Renewal' programme.

A smaller, but nonetheless significant contributor to city energy usage (up to 10% of electrical demand) is lighting. Technological advances in LED lighting enable huge reductions in energy consumption, as exemplified in Los Angeles, where the planned replacement of 209,000 street lights with LED systems will deliver a 40% cut in energy usage, reduce CO₂ emissions by 40,000 tonnes, and swell the city coffers \$10m annually¹.

Ultimately, reducing demand for energy will require behavioural change. As the former Mayor of London, Ken Livingstone, put it, "We don't have to reduce our quality of life to tackle climate change, but we do all have to change the way that we

live."² A large proportion of current energy usage is wasteful, such as lights left on in unoccupied rooms. Smart meters can help consumers understand the cost of the energy they are using and thus prompt behavioural change through the time-honoured incentive of saving money (see Inspiring Change article on pages 22-24 for further discussion).

Reducing demand for fossil fuel-derived energy is perhaps most difficult in relation to transport, where many people have developed a strong attachment to one of the most carbon-intensive forms of transit – the petrol/diesel car.

While new technologies offer the prospect of low carbon personal transport in the future (the German Government recently announced, for example, a plan to put two million electric cars on its roads by 2020), most cities will exceed their carbon targets if they can't achieve a fairly significant modal shift from cars to public transport, walking and cycling, and there are wider societal benefits to doing this, such as greater public space and improved health.

“And with 50-70% of existing buildings expected to still be in use in 2050, reducing energy demand by retrofitting existing stock will be a key policy instrument.”

At present, most are going in the opposite direction. One of the exceptions is London, where the combination of a ground-breaking road pricing scheme – the central London congestion charge – and significant investment in alternatives to the car, has achieved a 5% modal shift in the right direction. Significantly for the long term, this includes a massive 120% increase in cycling, albeit from a low base compared to some other European cities. *(Continues)*

¹ http://www.clintonfoundation.org/what-we-do/clinton-climate-initiative/resources/Lighting_LA_Case_Study.pdf

² London Climate Change Action Plan, Mayor of London, 2007



It is difficult to see how other well-established cities around the world can avoid adopting similar policies before too long. The lesson from London, Stockholm and Milan which have succeeded in introducing road pricing (along with those cities such as New York and Manchester which have thus far tried and failed) – is that it is possible to introduce charges for driving as long as there are clear alternatives, and the electorate doesn't have to vote on the proposition until after they have seen that it works.

“Helsinki supplies 84% of its heating from CHP and has become a net exporter of electricity.”

Improving efficiency of energy supply

Reducing carbon footprint by cutting demand for energy is essential, but will only get most cities part of the way towards a ‘safe’ global Earth share. London’s 2007 Climate Change Action Plan calculated that demand management could achieve roughly a third of its target to reduce emissions by 60% by 2025³.

Following the energy hierarchy principle, improving the efficiency of the supply of energy is the second focus of our approach. In the cities that have most successfully improved efficiency of energy supply to date this has meant moving away from reliance on a centralised grid, and installing decentralised heat and power networks using combined cooling, heat and power (CCHP) technology, which minimises wasted energy through capturing and using heat energy created in the process of generating electricity.

Compelled to action by the oil price shocks of the 1970s, and the lack of oil, gas and coal stocks in their own countries, Copenhagen, Stockholm and Iceland have led the world in this regard. Over a 30-year period, Copenhagen has connected 97% of its buildings to a district heating system⁴, cutting carbon emissions in the city by over a third as a result. Helsinki supplies 84% of its heating from CHP and has become a net exporter of electricity⁵.

So-called ‘smart grids’ offer another option, allowing energy suppliers to smooth supply over the day, for example

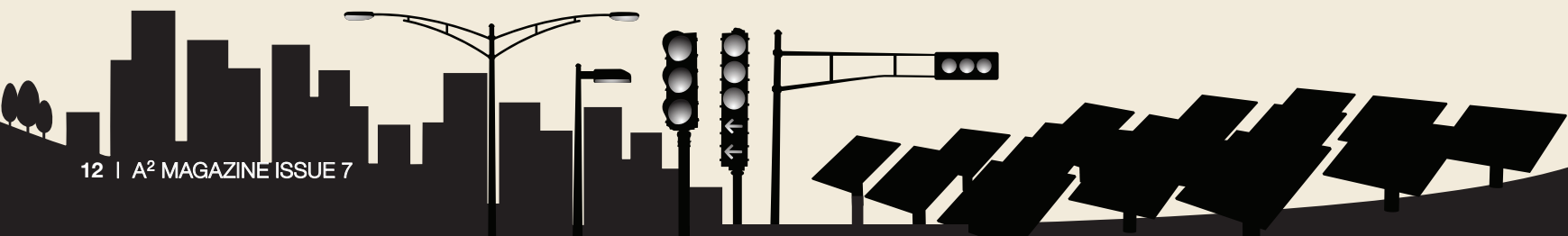


automatically turning down the temperature on washing machines during peak demand, via financial incentives to consumers to allow these minor, automated adjustments to their energy use.

Renewable energy

Having cut out wasteful demand for energy and maximised efficiency of supply, we come to the question of how to meet residual energy demand through the introduction of renewable energy sources.

Densely populated urban areas are unlikely to be the best sites for large scale renewable energy generation. However, there are often widespread opportunities for solar thermal and photovoltaics, and considerable scope for generating energy from the one thing every city has too much of – waste.



1 Photovoltaics in Barcelona, Spain

2 Transport for London's Legible London pedestrian information system

London's pledge to cut carbon emissions in the capital by **60%** by 2025

London calling

Isabel Dedring, Environment Advisor to the Mayor of London, Boris Johnson, tells A² how she is leading the drive towards environmental sustainability in the capital.

There are 3.1m homes in London and they all need to be more energy efficient. That's no small undertaking for Isabel Dedring's team, which is charged with carrying out London's pledge to cut carbon emissions in the capital by 60% by 2025.

"We're focusing on a few, large programmes that deliver the most 'bang for the buck' and can be scaled up over time," says Dedring, "as well as solutions that tackle the funding and 'hassle' factors, which have prevented residents from engaging with this agenda in the past."

London will spend over £100m on climate change initiatives over the next three years. Plans include programmes to green the Greater London Authority's (GLA) own buildings and fleet. The Mayor plans to introduce at least 1,000 city electric vehicles over the next five years – nearly double the total number of electric cars on London's roads today, as well as working with private and public sectors to increase the number of electric charging points to support 100,000 electric vehicles on the capital's streets.

"London's climate change targets are ambitious, but we know what needs to be done to achieve them; and it won't just be down to city government. Private sector organisations, the public and national government all have their roles to play. We won't achieve it without them." With this in mind, Dedring's team is also helping home owners and other public sector bodies to become more energy efficient.

Improving energy efficiency in buildings is a top priority for London, as the city's

building stock currently accounts for three-quarters of its carbon emissions, versus only 20% from transport. Part of London's energy efficiency plan includes a £9.5m home retrofit programme, which will be promoted in person, door-to-door across the capital, to encourage residents to fit loft insulation and other energy saving measures. And with funding a particular challenge in the wake of the recession, interest-free loans from local councils are also being trialled in London's 'low carbon zones'.

In retrofitting the city's own estate, Dedring's team has developed a new funding and procurement model. Currently acting as a demonstrator solution for these public buildings, the intention is to roll out the model to the public sector across the UK, leveraging regional economies of scale and presenting an interesting prospect for the nation's financial sector.

Decentralised energy, such as Combined Heat and Power (CHP) and district heating, as well as waste-to-energy strategies, are also a key component of the city's green plan. "We have committed to providing 25% of London's power from decentralised energy by 2025," Dedring continues, "and are currently energy masterplanning the whole of the city to identify attractive areas to introduce CHP, and sharing these plans with developers to give them sight of future development opportunities."

"Tackling climate change is an absolute priority for London," Dedring concludes. "It is certainly a challenge, but with 7.5m citizens, we have a real opportunity – not just for the city itself, but also for our residents, businesses, and the financial sector."

Of the many cities who had developed solar energy programmes in recent years, Barcelona has achieved perhaps the most dramatic growth, overseeing a ten-fold increase in solar heating in just three years, through the simple expedient of a municipal ordinance requiring that solar thermal panels are used to generate at least 60% of water heating demand in new buildings³.

While Scandinavian cities have long drawn energy from incinerating waste, Freiburg in Germany provides evidence that newer biological and compression treatments provide a far more efficient, and less polluting, method of generating energy from waste. Freiburg's anaerobic digestion plants now supply 25% of the town's electricity demand.

(Continues)

³ London Climate Change Action Plan, Mayor of London, 2007

^{4,5} SlimCity 'Knowledge Cards', produced by the World Economic Forum in collaboration with Arup, 2009

⁶ Ibid



An integrated programme

If it is easy to create a dream-team of interventions to reduce an ecological footprint, it is much harder to draw them together into a comprehensive, integrated plan for a specific city, and harder still to marry them with wider social and economic objectives – the final piece of the climate action plan jigsaw.

Yet this will be the key determinant of which cities emerge as the leaders of the new cities of the 'Ecological Age', creating places which are both the most attractive to live and work, and the most carbon efficient and resilient to climatic change.

There are some easy wins. A collaboration between Dutch light bulb manufacturer, Philips, and the London borough of Redbridge found, for example, that due to a better quality of light, crime rates fell and relative property prices rose in streets where LED lighting was installed⁷.

But as the task of tackling climate change requires root and branch change to cities' infrastructure, there will be many more instances where the cross-benefits of emissions reduction policies are not so immediately obvious, or where real conflicts emerge with other policy aims. Climate change policy has, therefore to be conducted at the most holistic level possible. In governmental terms, this means that responsibility for climate change has to sit across all other departments and report directly to the Mayor.

The scale of transformation required to fashion revamped cities capable of providing high quality living without destroying the planet for future generations, in an incredibly short timescale of just a few decades, is beyond anything humanity has had to cope with previously.

Yet 'Ecological Age' cities are a real possibility, if only we can achieve the perfect marriage between science, political and bureaucratic leadership, and technical expertise. Arup, through its work for the C40 and others, wants to put itself at the disposal of those who share a similar goal.

Finding integrated solutions for a developing world

Jo da Silva, Director, International Development, Arup.

Urban settlements in the developing world are starting from a very different baseline to those in higher-income countries. In Mumbai, for example, 50% of the population lives in slums, and while climate change may seem like a distant threat to citizens in developed countries, the developing world is feeling its impacts now, in the wake of rising sea levels, increasingly frequent flooding and severe weather patterns.

Reducing carbon emissions is not at the top of the agenda in developing countries, says Jo da Silva. Getting cities functioning with the basic infrastructure that is needed to support rapidly increasing urban populations and enable economic activity, to raise the quality of life for citizens, are the fundamental priorities.

Climate change is further compounding this challenge. 90% of urban growth over the next decade is predicted to occur in Africa and Asia, at a pace which is moving much faster than any planning process. Scientists predict that these cities will be hardest hit by climate change, and if their development does not adopt a low carbon pathway, they will quickly become the perpetrators of climate change too.

There are already one billion people globally living in cities without decent housing or access to water and sanitation, and this is predicted to double by 2030⁸. There will be a necessity therefore, for cities which have grown organically to instigate the robust urban governance and long-term planning frameworks required to deliver the strategic growth corridors, networked infrastructure and new nodes necessary to sustainably accommodate this rapid population growth.

Smart urban transport solutions, which provide access to jobs and markets while addressing congestion, will be integral to unlocking the future economic development of these communities and reducing carbon emissions. The planned Nairobi Commuter Rail System is a case in point here. "Fundamentally, this is about managing large scale urban growth in a resource-constrained environment where there is a global imperative to reduce carbon emissions."

"It's also about addressing development needs and mitigating risk at a local level," continues da Silva, whose International Development team is currently working with Habitat for Humanity to develop medium-rise, low-income housing solutions in Asia that can be built by home owners and local tradesmen and that are resilient to natural hazards. Delivery models such as these, that are localised, replicable, affordable, scaleable and reduce vulnerability, will be vital.

Building in resilience to the impacts of climate change which enables urban systems to recover and reorganise after a shock, as well as adapt to increasing stresses, is also crucial. Arup is currently working with the Rockefeller Foundation to support the development of resilience plans and create an evidence base of the characteristics that contribute to urban resilience to climate change, as part of the foundation's Asian Cities Climate Change Resilience Network.

Despite the difference in priorities, adopting an integrated approach to addressing these challenges remains as important in the developing world as elsewhere. The complex and symbiotic nature of the infrastructure networks and social institutions that make up cities is universal. In order to be effective, efficient and appropriate, plans and solutions must account for that.

⁷ Presentation by Philips to the Monaco 'Third Industrial Age' workshop, 2009

⁸ UN-Habitat : April 2007: The Challenge of Slums



THE LEGACY OF LEISURE VENUES

Educational establishments, parks and particularly leisure facilities, can play a vital role in cities, generating wealth, cementing communities and regenerating 'lost' urban areas. As committees deliberate locations to host major forthcoming tournaments, such as the 2018 World Cup, A² explores the key roles that arts, culture and sport venues play in a city, and how this legacy can be realised.

Centre stage

From grand concert halls to gleaming new sports stadia, leisure venues can form an integral part of any city, providing a sense of identity that communicates the city's values and history, fuelling aspiration and dynamism, and providing that all important legacy for the future. These venues offer a framework for civility, acting as a place where the community can gather to enjoy, celebrate and remember.

As a catalyst for economic development and regeneration, leisure facilities serve to attract tourists, investment and business growth, and in turn generating benefits for the local community such as employment opportunities, local skills and capacity, improved connectivity and increased land values.

The City of Manchester Stadium, for example, which opened in 2002 to host the Commonwealth Games, has since played a pivotal role in defining the nature of the eastern side of the city. More recently, Arup has worked with internationally-renowned sound and light artist, Hans Peter Kuhn and a partnership between Leeds City Council and Yorkshire Forward to transform Neville Street, a dark but key arterial route into the heart of the city (see adjacent images). Re-opened in October 2009, the once dark and dingy thoroughfare is now an attraction for the city's artists and tourists.

This page and next illustrate the 'Light' Neville Street project in Leeds, which has transformed a key arterial route into the city

© Emma Duffield Photography

“Sports and the arts are all about passion, performance and ambition and for this reason, these venues often reflect a city’s own ambitions and character, perhaps more so than any other buildings,” says Jim Burridge, Global Leader of Arup’s Sport business. “On a grander scale, sporting venues must inspire the city’s domestic and commercial residents, as well as attracting visitors. Community-based venues, especially, can serve to foster social engagement and deliver direct health benefits – ultimately creating a more active and cohesive community,” he concludes.

However, historically, not all large scale leisure facilities have been successful in delivering these benefits to their host cities. “Constructed for high impact events, we have witnessed some notable examples transcend from being the heart of the city to a white elephant in a matter of months due to lying unused,” notes Malcolm Smith, Director, Arup’s Urban Design team.

“Creating a positive legacy relies on making these venues work hard – both financially and commercially for the operators, and socially for the local community.”

Creating a positive legacy relies on making these venues work hard – both financially and commercially for the operators, and socially for the local community. But how is this achieved?

“The physical objects of buildings only account for a small percentage of what makes up a city,” continues Smith. “A lot is about how the building is operated and how you encourage citizens to engage with their environment. The craft of building



© Kippa Matthews

a legacy therefore starts with local people and empowering them to take part in the decision-making process of shaping places, by involving them in the consultation process for example, and localising ideas.”

Turning vision into reality

“Creating a long-term legacy around a leisure venue requires a vision not only for the venue itself, but also for the surrounding community – its buildings, infrastructure and transport systems, as well as its location in relation to the city centre,” adds Burridge. “The idea being to ensure these facilities remain accessible and useful to the community long after their original purpose.”

Maximising the use of the venue, both when hosting headline events and during down time, is of course vital to the commercial viability of the venue for the operators, as well as its positive role in the local community.

“When designing new venues, it is of course crucial to get the basics like lighting and acoustics right, but creating the right, often flexible, facility that maximises the number of revenue-generating events and is a natural ‘home’ for the local community between events, is critical to a venue’s success,” says Rob Harris, Leader of Arup’s Arts and Culture business in the UK and

Middle East. Arenas, for example, can host an amazing range of activities, not just sports. Whether it’s boxing, ice-skating or rock concerts, every event has its own specific requirements and venues must be designed to accommodate these different needs.

“As well as the hybridisation of buildings, we are also seeing mixed land use in order to attract maximum visitors,” adds Smith. “For example, you’ll start to see football stadia that have hotels, residential and arts facilities in them. Building up an arts quarter or sports village including cafés, restaurants and shops, will feed into the area’s economy by attracting people who might not otherwise visit the venue. Sharing joint facilities, such as parking and catering, can also serve to mitigate capital costs for developers, as well as providing ongoing savings to operators through more efficient energy use.”

Kings Place in London is a case in point here. This multi-award winning building, which opened in 2008, combines seven floors of office space with a 420-seat recital hall, a second performance space, art galleries, a café, restaurant and bar. This variety of uses and community involvement not only attracts tenants, but can also lift asset values and revitalise the local area. The project has challenged

1 The 'Light' Neville Street project in Leeds

2 The City of Manchester Stadium has played a pivotal role in defining the eastern side of the city

3 Kings Place combines office space, a recital hall, a second performance space and art galleries, as well as a café, restaurant and bar



the rules of 'planning gain', proving it is possible to make a major arts investment in a commercial setting that not only brings additional vibrancy and visitors to the building, but crucially, that it makes business sense.

“Creating a long-term legacy around a leisure venue requires a vision not only for the venue itself, but also for the surrounding community.”

“The importance of flexible venue design to maximise use and revenue also extends to attracting younger audiences,” continues Harris. “Take concert halls for example. Traditionally associated with serious classical music, many of these venues face the challenge of broadening their appeal to younger generations.” Contemporary design and the introduction of innovative performance concepts form part of the answer. “You have to attract young people to a location and make it an area where they want to spend time. They are then more likely to see a show on impulse, rather than booking in advance like older generations,” Harris explains.

In the future, Harris says this could mean providing low cost rehearsal facilities

for young people who are interested in music. New media initiatives, such as streaming rehearsals into schools as part of educational outreach and making performances available via the web also help to raise their interest.

With the delivery of such integral benefits to cities, leisure venues also have a responsibility to be sustainable – environmentally, socially and financially. Historically high consumers of energy, sustainable design and operation are vital in minimising the carbon footprint and costs of operating these facilities. New building designs incorporate passive energy and resource control measures, such as natural ventilation, solar shading and rainwater collection, and often alternative energy sources, including groundwater heating and cooling, biomass generation, solar water heating and photovoltaics – wherever it makes economic sense. In addition, a wider view of sustainability needs to be considered when planning these venues, including location close to public transport hubs, providing facilities for cyclists, and considering requirements for waste, materials and maintenance.

As a firm that works with clients to help achieve their sustainable business objectives, Arup is currently investing in research and development programmes

to find new ways of improving energy efficiency in leisure facilities, such as new techniques and operational technologies to reduce the energy used to treat water in swimming pools, whilst still achieving the required purity standards.

“Operating venues efficiently in extreme climates poses a particular challenge in terms of energy use,” comments Burridge. “We are also developing solutions to address this, such as mobile shading systems and passive cooling for locations with high day time temperatures, such as the Middle East, as well as examining how to efficiently recycle the heat and energy used in mixed-use winter sports and commercial venues in Russia.”

Telling a story for future generations

So, whether it's a school or university, a park, or indeed a multi-use leisure facility, we need to keep sight of the importance of realising a legacy not only for this generation but for those to come.

Malcolm Smith concludes: “Leisure facilities play a vital role in both memory and story-making. Venues where world records are broken and historical performances are given leave a resonant story of place, and act as physical manifestations of the history of the city, its people and their aspirations.”

HIGH PERFORMING PROPERTY PORTFOLIOS

The property market is undergoing a period of unprecedented economic turmoil and change. The value of property has been hit by one of the worst recessions of recent years and many investors and managers are struggling to understand how a changing world, new sustainability-related legislation and tenant demands will impact on their portfolios.

Arup's Jean Rogers and Nick Offer discuss the approach property portfolio investors and managers can take to transform their property holdings to improve financial, environmental and social performance; and why the time to act is now.

"Investors and property managers increasingly view a building's sustainability as a competitive issue. New regulations mean tenants are starting to look for efficient buildings, to reduce their own costs, and a building's standard is reflected in the value of lease agreements," explains Offer.

For property investors in particular, the introduction of guidelines such as the Principles of Responsible Investment (PRI) and the emergence of increasingly savvy stakeholders mean that it is now a fiduciary responsibility to ensure that their property investments are sustainable. They must consider issues of materiality that go beyond financial concerns. Drivers of global change and developments, such as net zero buildings, need to be considered and evaluated to enable investors to plan ahead, ensuring that portfolios maintain their value and remain a going concern into the future.

However, even in these uncertain times we can still move to tackle sustainability-related issues and adopt a new approach. Sustainability can effectively drive the successful transformation of portfolios, achieve high performance across the triple

bottom line and increase asset values. "Reduced operating costs, decreased turnover and higher market values have all been cited as benefits of sustainability in the property sector... High performing properties will be the cornerstone of economic recovery in the property sector, attracting capital and preserving net asset value," states Rogers.

For many portfolio holders, the first challenge is to understand how to adopt a more sustainable approach across their holdings. "Having a policy or signing up for something isn't enough," says Rogers. "You need to communicate it and follow through by having the resources and tools in place to support your commitments and drive real value."

"Reduced operating costs, decreased turnover and higher market values have all been cited as benefits of sustainability in the property sector."

Arup has developed the High Performance Property Portfolio (HPPP) toolkit to provide strategic advice to help property investors transform their holdings and achieve high performance across their portfolio. The toolkit covers planning, optimising performance, governance and continual improvement, taking investors through the steps required to achieve high performance holdings, which deliver across the triple bottom line. The toolkit's content spans the complete property lifecycle and provides timely advice and insight to help property holders position their portfolios. This will help them to capitalise on opportunities created by a market in recovery, meet investor demands and maintain a competitive edge.



Most importantly, it covers some of the most crucial areas portfolio managers need to focus on to preserve and create value over the long term, including identifying trends within the built environment and managing risk.

Risk management is crucial to optimising a property portfolio, explains Rogers. "It's about identifying risks and opportunities and prioritising them, based on a cost-benefit analysis. This includes modelling vulnerability and assessing whether to take, transfer, or mitigate risk, rather than just insuring yourself in case."

Metrics and KPIs are provided for each section of the guide to assist portfolio holders to develop the mechanisms to report on their progress to key stakeholders. This allows them to set benchmarks to rate their own practices and identify further solutions for improving performance. The need for governance and reporting is critical in ensuring that performance is measured and managed. "It is vital to have the right metrics in place and to



© James Brittain Photography/Wildinson Eye Architects

understand what the key performance indicators are,” states Rogers.

Arup has also developed the Existing Building Survival Strategy Guide which complements the HPPP toolkit by helping companies to understand the practical interventions they could implement to make properties more energy efficient and adhere to regulations.

Historically, developers have veered away from investment in energy efficiency, because the payback period seemed too lengthy or difficult to calculate. Legislation introduced in the UK last year requires that all buildings bought, rented or sold have an energy performance certificate (EPC). “These regulations and rating systems mean people need to start examining how to retrofit existing building stock, bringing it in line with new requirements,” says Offer.

The Existing Building guide adopts a five-step approach. It guides developers and owners through the process of determining a baseline, reviewing how their buildings are operated and maintained, establishing

goals, selecting upgrades and making their survival strategy a success. The guide also offers 195 practical ways to improve a building’s energy efficiency.

“As newer net zero buildings come on line, existing building stock will find it more difficult to compete... They need to adapt, or they could become obsolete.”

It is not just portfolio holders who should be concerned about the sustainability of their holdings. Within the urban environment, improving the sustainability of a city’s building stock is central to reducing carbon emissions, with studies showing that over 70% of greenhouse gas emissions come from existing buildings. The focus also needs to be on more than just reducing greenhouse gas emissions. As newer net zero buildings come on line, existing building stock

will find it more difficult to compete with these new, more resource efficient buildings. They need to adapt, or they could become obsolete. Cities that tackle building sustainability now will remain competitive in a resource-constrained world; those who fail to make the grade may well find themselves struggling to attract new tenants and corporations. This could in turn have a major impact on the communities they support.

“No one really knows how the development of net zero buildings will play out, but this is one of the biggest discontinuities we have seen in the history of the built environment. There will certainly be a huge shift in demand – as tenants prioritise energy efficiency. If existing buildings aren’t the best they can be, demand for low impact, highly productive new building stock will undoubtedly increase,” says Rogers.

The Association of British Insurers reports that last year was one of the costliest catastrophe years in history. Globally, economic losses linked to floods, storms and hurricanes, among other disasters, totalled nearly \$200bn – a threefold increase from 2007. Many of these losses were focused in urban areas and, in addition to the social benefits and moral obligation, increasing the resilience of cities to catastrophic events has a sound economic rationale.

PROTECTING THE CITY



Opposite:
Real-time 3-D model of
Southampton Docks. Built
from aerial and terrestrial
LiDAR scan data

Nick Pope of Arup's Resilience practice argues that in order to protect their citizens, infrastructure and businesses, city leaders need to have a detailed understanding of the diversity of the risk landscape both over the short and long term, build a resilience strategy into the masterplan of the city and recognise that citizens themselves can play an integral part in increasing a city's resilience.

The risk landscape

Cities face a wide array of risks including natural disasters, terrorism, flu pandemics, demographic change, an increasing population relative to resources and crime, to name just a few. The importance of these risks varies both spatially and temporally and every city needs to understand both its unique risk landscape and its own inherent characteristics (culture, location, environment, infrastructure, etc.) in order to put effective resilience plans into place.

“Designing a city now to cope with these future risks will not only protect people and assets, but also save huge costs in retrofitting later down the line.”

Although there is an increasing awareness of short-term risks within cities, what Pope calls ‘creeping risks’, such as climate change, have not historically been top of the agenda. However, climate change is arguably a principal risk for every city, with the potential to impact food, water and electricity supplies – the networks that keep society functioning. If, as scientists predict, the frequency and severity of weather-related disasters increase and temperatures rise, not only are food supplies likely to be put under pressure but people are likely to want to locate in the same habitable areas, vying for limited resources and space.

A greater concentration of people coupled with demographic shifts will in turn increase the risk of crime and disease.

“Population displacement and resource scarcity have been highlighted as two of the key risks to humankind,” Pope explains. “Designing a city now to cope with these future risks will not only protect people and assets, but also save huge costs in retrofitting later down the line.”

Risk evaluation and preparation

Risk should be evaluated across three main areas, advises Pope. Firstly, he explains, cities must, where possible, identify their risk landscape and estimate the likely return period and magnitude of the threats and hazards faced. Secondly, cities must evaluate the vulnerability of their people and physical assets. Thirdly, they must consider the immediate and longer-term consequences associated with the risks, such as the length of disruption to core operational services and the corresponding financial impact of that disruption.

Once a clear picture of the risk landscape has been built up and risks prioritised, cities should ensure preventative measures are built into the city's very fabric. “Integrating a good risk management and resilience strategy into the masterplan of a city reduces the likelihood of gaps in the system and possible unintended consequences of piecemeal activities. Looking at the built environment for example, individual building resilience can be woven into the infrastructure of a whole area. This ensures that one building doesn't stand off against another and crime isn't displaced from a more secure to a less secure area,” explains Pope. “Crime prevention through environmental design is actually one of the most developed approaches to reducing criminal activities and increasing a sense of safety in our surroundings.”

Response

Cities that prepare and take a long-term approach to resilience will be better placed to protect their people and assets against known and unknown future threats. But Pope cautions that preparedness is just one element of protecting a city. “How you respond to a crisis can be even more important than planning for one,” he says.

“Integrating a good risk management and resilience strategy into the masterplan of a city reduces the likelihood of gaps in the system and possible unintended consequences of piecemeal activities.”

The 2007 floods in Britain were the most severe in a century. Roughly 48,000 homes and 7,300 businesses were flooded, causing billions of pounds worth of damage. Across Gloucestershire, a county in England, 350,000 people were left without a mains water supply. This marked one of the most significant losses of essential services since the Second World War, according to a report published earlier this year by British think tank Demos, to which Pope contributed.

“In the past, governments alone have been responsible for ensuring the safety and security of the country, its people and the economy, but communities and individuals are an incredibly effective resource,” says Pope. “Take for example, an individual being able to spot a package out of place and prevent a possible terrorist attack, or knowing what to do in the event of a flood. The effectiveness of bottom-up approaches is beginning to be recognised but individuals and the communities in which they live are still a largely untapped resource.”

Clearly there isn't a one size fits all approach to improving the resilience of our cities but Pope believes that unlocking the potential of communities could be one of the most effective strategies moving forward. “There is always more we can do in terms of measuring, predicting and preparing for risk in cities – and it is vital that we do more – but we'll never get it 100% right, there are just too many variables. Consequently, our response to disasters is vital. By focusing on communities, we have the best chance of making that response rapid, tailored to local needs and ultimately effective.”



The behaviour of people within a community is influenced by a combination of social, psychological, physical and economic factors. A² explores how these factors need to work together to enable truly sustainable cities.

INSPIRING CHANGE

“We have an addiction to fossil fuels, and it’s not sustainable,”¹ says Chief Scientific Adviser to the UK’s Department of Energy and Climate Change, David MacKay, in his recent book, ‘Sustainable Energy – without the hot air’. It is argued that the shift from an unsustainable model of living that is heavily reliant on climate-warming fossil fuels to a prosperous low carbon economy will depend on the choices of people, as well as governments.

There’s no shortage of advice on how to “make a difference,”² writes MacKay, but the public is confused, and some even suspicious about the actual contribution individuals can make.

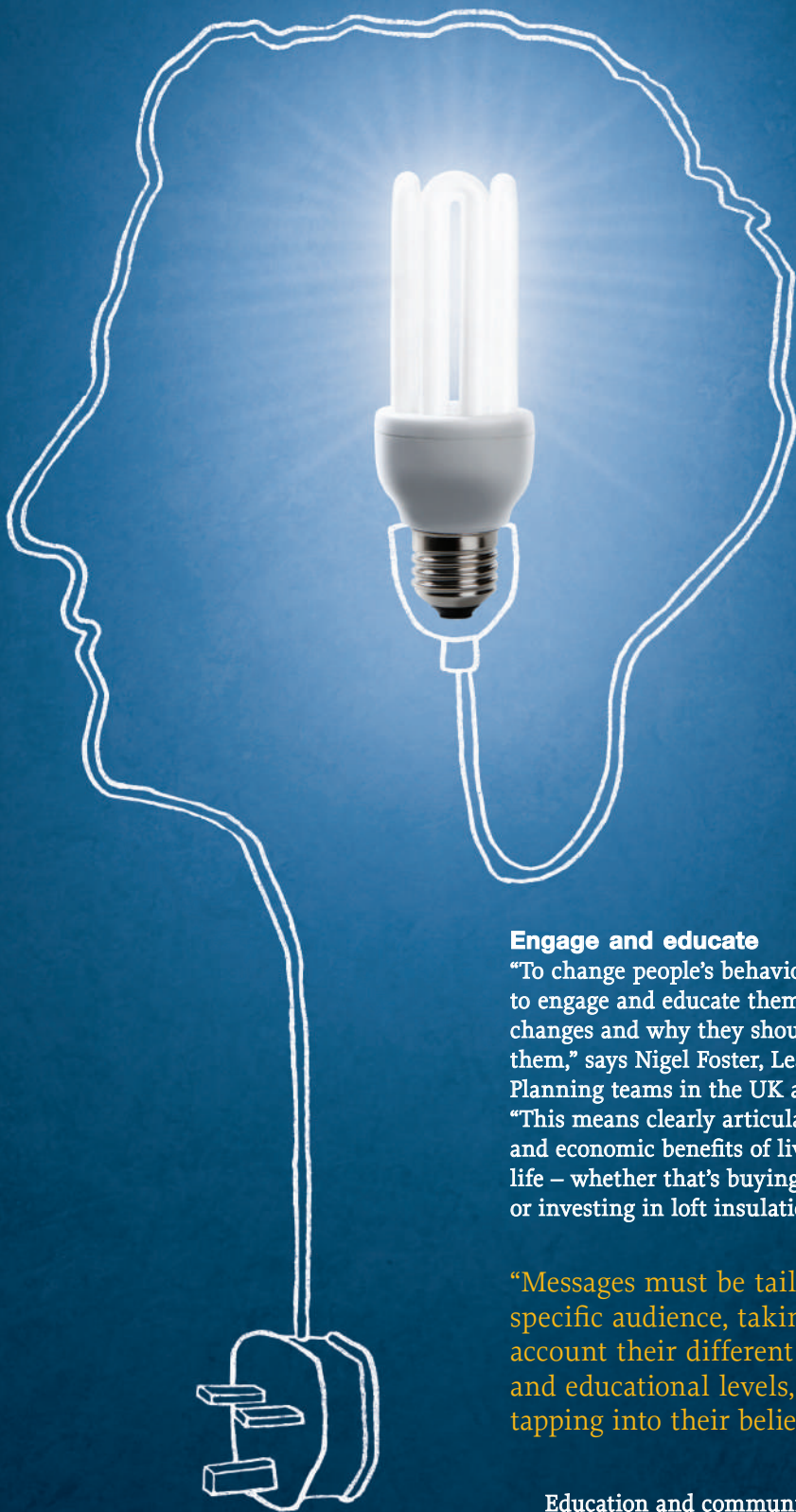
Common goals

As the most devastating impacts of climate change are still likely to be a generation away, it is largely viewed by the public as a distant, intangible threat that can be dealt

with later. Establishing goals and rewards can help people to recognise the immediate impacts of their behaviour on the earth, and treat responding to climate change with more urgency.

“There is a strong link between more sustainable outcomes and individuals’ perception that they are making a meaningful contribution.”

“There is a strong link between more sustainable outcomes and individuals’ perception that they are making a meaningful contribution,” says Alice Owen, Associate Director in Arup’s Planning team. “City leaders have a tremendous role to play in influencing this ‘social logic’, but they must use a shared common vocabulary that speaks to people’s aspirations.”



“The relative cheapness of fossil fuels means that many people don’t worry about wasting energy... City leaders need to empower citizens with the information to make more sustainable choices.”

Engage and educate

“To change people’s behaviour, it is crucial to engage and educate them about the changes and why they should be making them,” says Nigel Foster, Leader of Arup’s Planning teams in the UK and Middle East. “This means clearly articulating the social and economic benefits of living a greener life – whether that’s buying an electric car, or investing in loft insulation.”

“Messages must be tailored to the specific audience, taking into account their different backgrounds and educational levels, as well as tapping into their beliefs and values.”

Education and communication play crucial roles in city leaders’ ability to engage citizens with these plans for the future, says Harrison. “Messages must be tailored to the specific audience, taking into account their different backgrounds and educational levels, as well as tapping into their beliefs and values,” she adds.

Providing better information is also key. “People often make unsustainable decisions simply because of poor information,” says Mark Watts, Arup Director working on cities’ climate change policies. “The relative cheapness of fossil fuels means that many people don’t worry about wasting energy,

but actually very few people are happy to waste money. City leaders need to empower citizens with the information to make more sustainable choices.”

The most likely information source is through technology, enabling people to see how much energy they’re using and how that’s affected when they change their behaviour, like switching off lights or walking rather than driving. For example, smart metering trials in the town of Växjö in Sweden recorded average reductions in energy usage of 24%³.

We can also look to Transport for London’s ‘Legible London’ project as a clear example of how information is changing behaviour. This new pedestrian way-finding system, developed with programme management support from Arup, encourages people to walk rather than drive or take public transport. “One of the main reasons people don’t make short walking trips is because they don’t necessarily think of it as an option, usually because they misjudge the distance and wrongly conclude that public transport would be quicker. So, the project has introduced a series of carefully-designed maps around London that show where walking is a feasible alternative and how long it will take,” says Watts. In its prototype stage, Transport for London reported that 62% of interviewees stated that the new system would encourage them to walk more.

Our need for a sense of identity and desire to be part of a group can also be key drivers to conform, adds Amanda Harrison, Occupational Psychologist in Arup’s Operations Consulting team. “People will naturally strive to be part of a group, so demonstrating the benefits of change to particular groups and harnessing social networks is vital to influencing behaviour, because people are then motivated around a common goal.”



Market mechanisms

Creating market mechanisms that reinforce sustainable behaviour in a community will also play a vital role in realising cities' plans, says Watts, who was previously climate change advisor to former London Mayor, Ken Livingstone.

"Ultimately, it's not possible to meet climate change targets without a price of carbon that encourages people to change their behaviour," he continues, citing the example of the London Congestion Charge which was introduced in 2003 by Ken Livingstone.

"Ultimately, it's not possible to meet climate change targets without a price of carbon that encourages people to change their behaviour."

One of the political 'hot potatoes' under Livingstone's administration was traffic. "The challenge was to devise a pricing mechanism that would seriously cut congestion, but which created more winners than losers so that it could win popular support," Watts recalls.

Watts notes that it is expected that roughly one third of London's objective to cut emissions by 60% by 2025 will be achieved by people changing their behaviour through a combination of carrot-and-stick pricing mechanisms, like the congestion charge, and new feed-in tariffs. These tariffs will enable people to sell the energy they don't consume back to the national energy grid at a guaranteed price.

Involving citizens in designing such schemes, via a consultation process for example, can also help to secure their buy-in and therefore increase adoption and behavioural change when these schemes are implemented.

"Much of changing people's behaviour is about influencing their lifestyles, but people need to understand that this change doesn't have to be negative," concludes Foster. "It means a lower consumption of resources and a less 'throw away' society, but it doesn't have to mean a lower standard of living."

¹ www.withouthotair.com/synopsis10.pdf

² www.withouthotair.com/synopsis10.pdf

³ SlimCity 'Knowledge Cards', produced by the World Economic Forum in collaboration with Arup, 2009

Designing for people

The built environment forms the context for our daily lives – from our homes to civic buildings, places of work, places of learning and so on, all linked by public spaces. The quality of our lives is strongly influenced by these elements. As designers, we believe that the behaviour of people is also influenced, as is their ability to fulfil their potential. There is a two-way interaction, so that the built environment influences people and in turn they will engage with and celebrate their responses to environments designed with them at the heart of the design agenda.

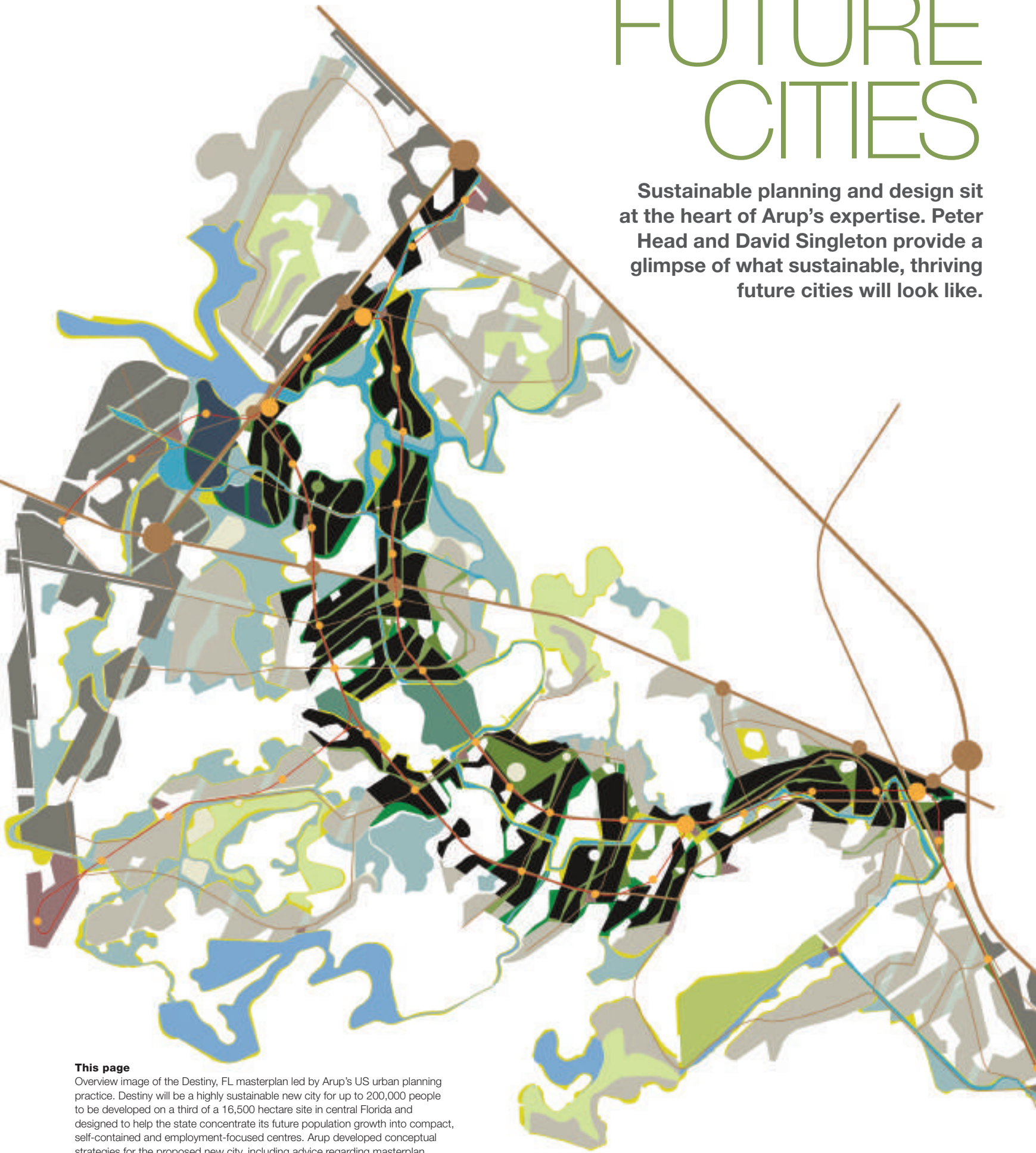
We are emerging from the age of the 'icon', where the reliance on the individual haute designer is recognised as not serving society well. The problems and challenges of the 21st century are complex and diverse with the active engagement of individuals and their communities. It is natural that we organise ourselves in a way that responds to the new demands of society and opens up a world of interest and opportunity.

We will move away from a culture of formulaic surface style independent of context, to a culture of collaboration, and integration of specialists in new areas of thought and relevance to our communities, to create a shared ownership of design through studios and society. An expansive, open-ended culture best serves individuals and their communities to allow them to fulfil their potential. We term this approach Unified Design.

Declan O'Carroll, Arup Associates

FUTURE CITIES

Sustainable planning and design sit at the heart of Arup's expertise. Peter Head and David Singleton provide a glimpse of what sustainable, thriving future cities will look like.



This page

Overview image of the Destiny, FL masterplan led by Arup's US urban planning practice. Destiny will be a highly sustainable new city for up to 200,000 people to be developed on a third of a 16,500 hectare site in central Florida and designed to help the state concentrate its future population growth into compact, self-contained and employment-focused centres. Arup developed conceptual strategies for the proposed new city, including advice regarding masterplan concepts, programming and land use, and sustainable development guidelines.

1 Guidelines, including land use and massing concepts, for compact development typologies that reduce suburban sprawl while still accommodating local lifestyle expectations

2 Rendering of a proposed energy-oriented technology park – one of three planned on the Destiny site

3 Rendering of a lower density residential neighbourhood on the Destiny site



Declining resources, climate change and growing urban populations will transform the cities of the future. But what will these urban centres actually look like? Will they be buzzing metropolises, where people live and work atop soaring skyscrapers? Perhaps they will have swathes of green space and gleaming solar panel-covered homes and offices. Or perhaps the cities of the future won't be cities at all in the conventional sense, but rather a collection of hubs for specific types of commerce and resources.

Building successful cities of the future – whether from the ground up, as is often the case in developing nations, or retrofitting existing urban centres – will require a harmonisation with natural surroundings and biodiversity. Arguably, there has never been a more compelling time to consider how to bring these future cities to life.

In low-income countries, like China, where many new cities are under construction, it will be important to develop with a much lower reliance on climate-warming fossil fuels, asserts Peter Head, Global Leader of Arup's Planning teams. In this way, Head questions whether high-density megacities are the right solution, given the significant emissions that result from moving people, goods, food and water across such large settlements.

"The development of a network of decentralised mixed-use settlements, or 'clusters', connected by high speed public transport and broadband communications, may be a more sustainable and resilient solution," he continues. Connected by areas of intensive agriculture and natural systems, this decentralised model allows

for the recycling of nutrients and water, as well as greater use of local materials in fashioning new forms of urban beauty. The forms will be strongly influenced by water availability and the latitude for food production. Certain 'clusters' may eventually evolve into centres which offer particular commercial and social facilities, such as high-tech, healthcare or education. Information and communication technologies would serve to minimise the need to travel between the hubs, so reducing carbon emissions and demands on local infrastructure.

"The development of a network of decentralised mixed-use settlements, or 'clusters', connected by high speed public transport and broadband communications, may be a more sustainable and resilient solution."

This model could also free up capital to enhance social well-being. The infrastructure needed to support the modern day industrialised nation absorbs so much capital that it can limit the resources available to invest in human development, health, education, and so on, says Head.

"We got the balance wrong, particularly in low-density sprawl," he continues. "The new paradigm of development and urbanisation requires a new economic model that puts resilience and the efficient

use of resources at its heart. It will be driven by three changes in economic thinking. The first is placing a greater value on the protection of the eco-system by, for instance, establishing a high carbon price to reward green living and penalise waste. Second is the fair distribution of resources, to ensure renewables are priced so they are not just for the wealthy, and the less well-off have access to local services. And the third is promoting the efficient use of renewables via legislation that incentivises people to think more carefully about the amount and type of energy they consume and promotes the provision of renewable energy."

In high-income countries, retrofitting existing cities for a low carbon future must be the focus, with 50-70% of existing buildings still expected to be in use in 2050. In low-density suburbs, like those common in the US, Head suggests retrofitting could start with putting very high-density mixed-used interventions into new public transport node points, thereby creating a new vibrancy and services, without dramatically changing the landscape of the suburb itself. "You can then refashion the streetscape by introducing walking and cycle routes, renewable energy capture, and car clubs to reduce car use, all of which would serve to deliver a significant reduction in CO₂ emissions," he concludes.

Part of this shift may mean that some suburbs become increasingly populated, while others are abandoned and are returned to greenfield sites, used for agriculture.



“Pension funds, for example, are an increasingly attractive source of capital to fund large scale renewable energy projects and long-term environmental development.”

requirements of different tenants, thereby maximising efficiency and value. You can envisage apartments that become offices and vice-versa, with roofs used for intensive food production.”

Achieving this vision with sufficient speed will require that planning structures are revised. A flexible and integrated approach to waste, water, energy and mixed land use must be employed.

How cities will fund the transition to a low carbon future is probably the biggest question on the minds of every politician. The financial crisis has left many investors looking for new opportunities to replace the value lost in equity and property markets. Pension funds, for example, are an increasingly attractive source of capital to fund large scale renewable energy projects and long-term environmental development. However, investors need assurance that regulators will follow through on future sustainability promises. “National and international climate policies, and a stable and high global carbon price will play a crucial role here. They will clear the way for greater investment in areas including energy efficiency, renewables and green transport,” Singleton adds.

Planning a smart, successful city of the future is fundamental to the city’s survival. But there’s also an opportunity to create wealth. In Europe for example, where freedom of movement has decreased the importance of national boundaries, cities in different countries now compete for the same labour pool and investment. As the impacts of climate change begin to unfold, and urban populations continue to swell, the cities that are the most prepared and embrace renewable resources will also be the most attractive.

“When we think of future cities, we need to think as much about retrofitting existing cities as planning new ones,” concludes Singleton. Both have a critical role to play. “Cities, whether newly built or not, will govern our cultural and economic future.”



Urban planners are already incorporating intensive food production into cityscapes, building in greater resilience to the impending global food crisis and reducing our over-dependence on lean supply chains. For example, in Wanzhuang eco-city, in an area of China with huge water shortages, Arup’s urban designers proposed an integrated urban agriculture and food system which replaces extensive wheat and corn cropping with labour intensive vegetable and fruit cropping. In doing so, the strategy delivers 100% food security for fresh fruit and vegetables for the new community and significantly reduces water consumption, as well as doubling farming income and increasing by 50% the number of jobs related to agriculture in the area.

The preservation of green spaces also has a vital role to play in dense, down town areas, improving drainage and air quality, helping combat the urban heat island effect and improving health.

“Inner-city areas will also see increased public transport provision, particularly underground metro systems, to reduce heavy traffic and the associated emissions,” predicts David Singleton, Chairman of Arup’s Global Infrastructure Practice. “Taken with a greater focus on walking and cycle routes, cities of the future will be much quieter than the contemporary metropolis.”

Flexible building design is another important development, he continues. “Designing buildings that accommodate multiple possible uses will respond to rapid changes in demand and cater for the

A WINNING FORMULA

How mathematical algorithms are optimising building designs

Arup has pioneered the use of mathematical algorithms to create designs that deliver effective buildings and maximise value for developers.

“Quite literally, optimisation means making the best or most effective use of a situation, opportunity or resource,” explains Giulio Antonutto, a Senior Designer at Arup. “If you can describe a problem mathematically, then you can use optimisation to work out the best possible design based on your performance criteria.”

The approach has the potential to optimise building design for criteria as diverse as wind speed, noise, shadows, costs and other requirements. By adding these criteria to an algorithm, designers are presented with a range of solutions that meet their requirements – for example, designs that deliver more volume or are more cost-effective to construct.

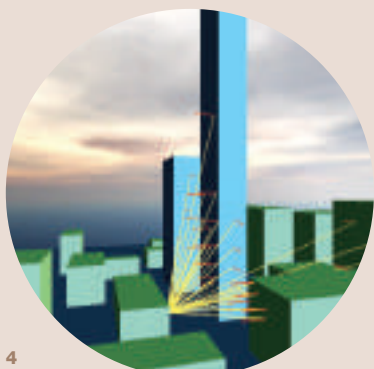
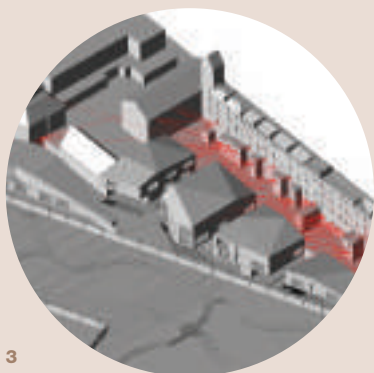
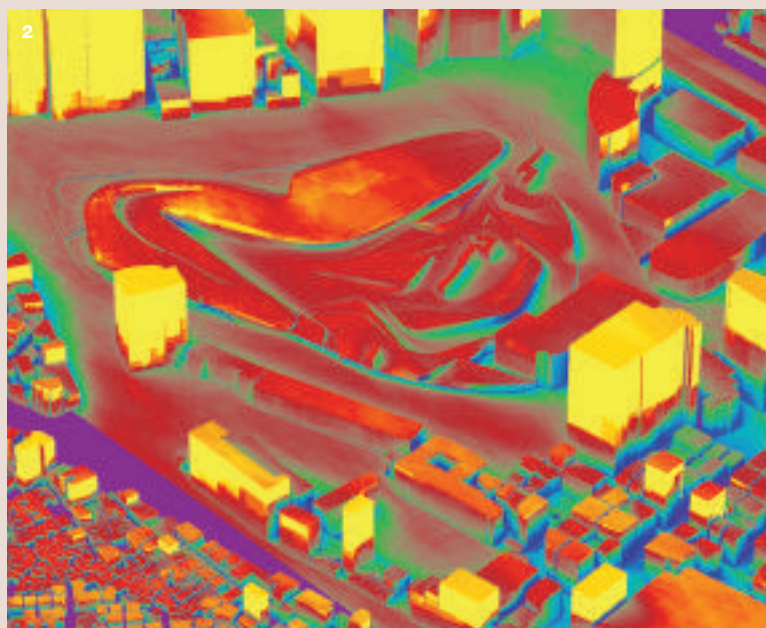
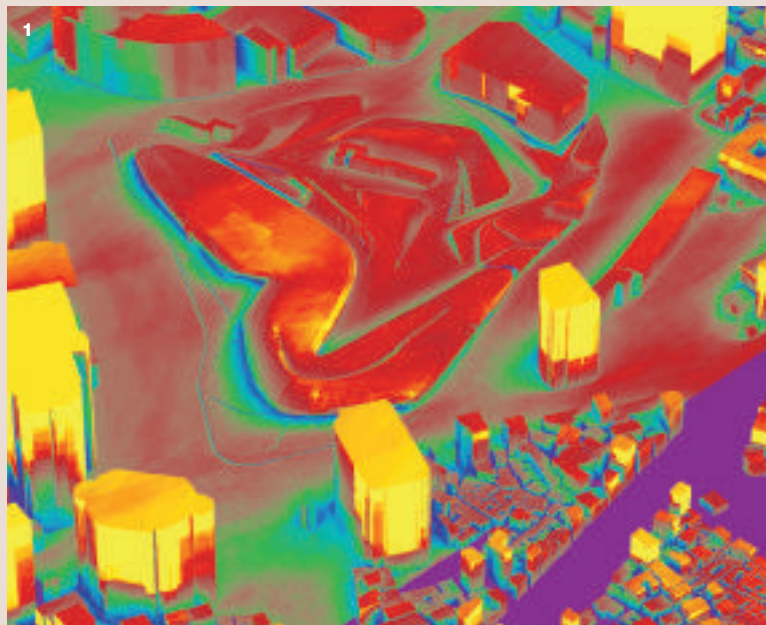
Giulio and his colleagues have already used optimisation extensively to address daylight and sunlight availability in urban planning – finding designs that include the largest possible volume while meeting BRE recommendations on sunlight and daylight for neighbouring properties.

“Traditionally, you might have to cut off a building design above a certain angle from neighbouring properties,” says Giulio. “But by using optimisation to consider a range of criteria such as floor height, number of floors and the shape of your development, you can arrive at different solutions.”

A recent development project, applying the BRE rule of thumb for sunlight and daylight, meant the volume of the initial building designs would have to be reduced by 30%. Through optimisation, Arup arrived at a solution which met the BRE recommendations and gave the developer 90% of the initial volume – increasing the value of the project.

With optimisation, designers can run an algorithm on a computer and within just a couple of hours be presented with a ‘cloud’ of solutions that meet the different performance criteria. The design team can then choose their preferred solution and develop it further. The process may use some advanced mathematics, but the results are easy to visualise.

“One way to see the results is to provide clients with a library of solutions,” explains Giulio. “That could be done with an animation where they can browse through different options. We can also use game engine technology to enable clients to interact with a design. If we’re looking at sound as a criteria, then the results can be modelled in Arup’s SoundLab.” (See page 30.)

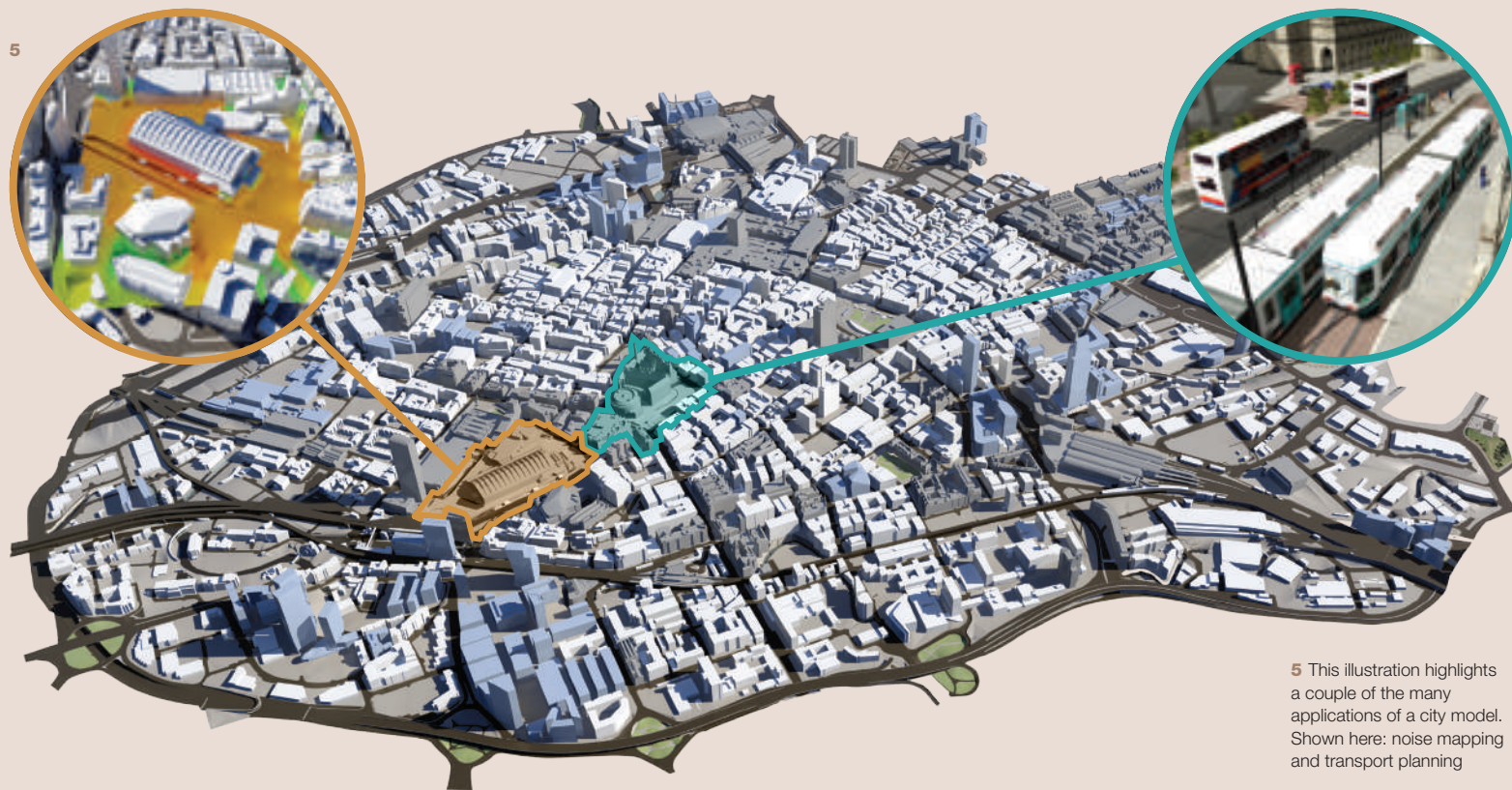


Giulio points out that even architecture has a long history of embracing the principles of optimisation – from Bernard Rudofsky to Bruno Zevi. Optimisation is important, he believes, because of the possibilities it presents. “You can apply optimisation to anything where you can use an equation to describe the problem,” he explains. “It’s a tool with a wealth of possibilities.”

- 1 Optimisation techniques can be used to modify the building envelope and, for instance, reduce reflected glare
- 2 Sun hours plot can be generated for every design option. Optimisation techniques are used to modify the site parameters until all constraints are satisfied
- 3 Modern ray tracing techniques are used to calculate sunlight and daylight availability
- 4 Interactive visualisations enable the design team member to explore the site model in 3-D, modify or select solutions for the proposed development

THE BIGGER PICTURE

How digital 3-D models help cities fulfil their potential



5 This illustration highlights a couple of the many applications of a city model. Shown here: noise mapping and transport planning

Detailed, digital 3-D models created by Arup are helping UK cities plan development effectively, run public consultations and market themselves on the international stage.

“3-D models give cities the chance to look at development proposals in situ,” explains Steven Lesser, Associate Director in Arup’s 3-D modelling team. “Rather than producing different models for each new development, it makes sense for city councils to have a single model to look at developments in a wider context. They are produced accurately, to defined tolerances; they are not purely a visualisation tool but are trusted to such an extent that they can be used at Public Inquiry.”

Built using open source software, the models can be accessed easily and shared over the web – making them cost-effective and versatile. “Rather than exploiting the data in the model commercially, Arup

develops them as royalty-free assets for city leaders, developers and other organisations to make use of,” explains Lesser.

Thanks to Arup’s investment in the technology, the 3-D models are quick to produce: modelling a whole city centre from scratch could take just three months. Although the exact methods vary, Arup’s 3-D modelling team usually employs a combination of laser-scanning and photogrammetry – an aerial survey technique that combines two photographs to produce a ‘stereo effect’ that forms a detailed 3-D model.

Replacing a cumbersome physical model, the firm’s digital 3-D model of Manchester now covers 25km² of the city centre and its surroundings. Arup has also completed 3-D models for Leeds and parts of Glasgow and Edinburgh, and is developing one for Liverpool. The technology is gaining interest from around the globe. Simon Mabey, the 3-D

modelling Team Leader, has been invited to speak in East Asia and Australasia in November.

Manchester City Council asks developers to produce models that are compatible with its city model and, in return, allows them to use the city model to market their developments. For an urban regeneration project in East Manchester, developers used the 3-D city model to assess the visual impact of the development and maximise its potential within planning requirements.

The digital model brings the city to life for potential investors and does the same for the public. Manchester and Leeds have used their city models as a marketing tool at MIPIM – the global property fair held in Cannes each year.

As 3-D models can display almost any kind of data, they have a wealth of applications. Arup is working with the Greater Manchester Integrated Transport Authority (GMPTA) to produce

a detailed real-time model of proposals for traffic in the city’s Oxford Road corridor – one of the busiest bus corridors in Europe.

Arup’s 3-D modelling team is also expanding the modelling process to include city information modelling – adding data about everything a city needs to run, from street lights to public property, to 3-D building models. “There’s a lot more to come,” says Mabey. “City models have great potential for the future. They will become standard for cities and Arup is working to make sure they can be used effectively.” Roger Milburn, UK-ME Government Business Leader for Cities, Local Authorities and Regeneration, adds “The future is clear – that all cities and communities will have such a model to help plan, design, deliver and manage their environments. Our clients are starting to realise the potential for these models and how much time and money can be saved.”

SOUNDING OUT OUR CITIES

How understanding soundscapes can help design effective urban areas

“A soundscape is the barometer of a city’s health,” says Neill Woodger, Arup Director and acoustic specialist. “By understanding the sound of a city, you can create attractive, stimulating and healthy acoustic environments – places where people can live, work and play happily and effectively.”

It’s a concept that Arup has put into practice along the East River in New York, to reconnect the city to the water by encouraging people down to the river. Here, Woodger and his team created a sound walk that identified eight distinct soundscapes along the river – from noisy bridges to the quieter area by the old port.

The information that Arup’s unique SoundLab produced helped designers decide where to put things like communal outdoor spaces or where outdoor seating would need protection from noise. Decision-makers could hear designs before they were built – ensuring any investment creates the required value.

SoundLab is an auralisation tool that uses ambisonics (multi-channel sound recordings) to create a realistic impression of a soundscape. Enter an Arup SoundLab playing a recording of the East River environment and it’s as if you’ve stepped into New York.

To achieve this, Arup’s specialists take recordings on location using 3-D microphones. SoundLab then enables designers to hear how control devices, such as trees and walls, can help block out sound and how features such as fountains will add in natural sounds that are pleasing to hear.

Crucially, SoundLab allows decision-makers to compare a design with a reference soundscape from another city. So if you’re trying to capture

the ambience of Athens or the romance of Rome, SoundLab can let you experience them in direct comparison to your design – helping to ensure that you get what you want.

This approach informs design decisions at an early stage. “A soundscape is the result of a combination of design decisions, it’s not something you set out to create,” Woodger explains. “It’s not the case of adding sound into a design to achieve the desired result. If you want the sound of people having fun, you need to create a place that lets them have fun.

“SoundLab gives architects who are interested in how people experience environments the tools they need to create successful designs.” Close to the East River project, Arup also worked on a proposed new playground, a rich environment of diverse materials that encourages unstructured play. With SoundLab, the architects were able to hear the sound of children playing and how noise from the road could be screened – helping them to develop their design.

Arup has pioneered the use of SoundLab in concert hall design, but the tool also helps with design decisions for other buildings within cities. Does a proposed hotel need to spend money on isolating its building from road or aircraft noise? Will a new football stadium have the right atmosphere? These are questions that SoundLab can help clients answer.

In the future, soundscapes will play an important role in understanding the changing way we will live in cities. What will it be like to live in a city full of quieter electric cars? How will this affect people’s behaviour? The answers to these questions could soon be heard in Arup’s SoundLab.



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Shown here: London and Melbourne SoundLabs

Emerging *from electric cars to out of Africa* markets

THE GROWTH DRIVERS EVERY
CEO NEEDS TO KNOW ABOUT

NEXT ISSUE

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