

Top Ten Urban Innovations

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Introduction

In the 1990s, as the digital revolution began to gather pace, some social commentators speculated that it would lead to the death of the city. People's geographical location would become less important, the argument went, as they came to interact mostly in cyberspace.

Two decades on, the opposite has happened: human beings continue to live very much in the physical realm, and early this century passing the turning point of more people living in urban than rural areas. The UN predicts that by 2050 the world's urban population will be as big as the world's total population in 2002. But what will the cities of tomorrow be like?

People continue to be drawn to cities by the economic, social and creative opportunities they offer; large cities are more productive than rural areas, producing more patents and yielding higher returns on capital. [McKinsey estimates](#)¹ that the world's top 100 cities will account for 35% of global GDP growth between now and 2025.

However, urbanization also presents major challenges. The world's fastest growing cities have seen problems adjusting to growth and industrialization, choking under the burden of pollution, congestion and urban poverty. In the developed world, urban sprawl can lead to individual levels of resource consumption far exceeding those in the developing world. Urban settings magnify global threats such as climate change, water and food security and resource shortages, but also provide a framework for addressing them.

If the future of cities cannot be one of unsustainable expansion, it should rather be one of tireless innovation. This report chronicles 10 of the best examples from around the world of how cities are creating innovative solutions to a variety of problems. Many of these solutions are scalable, replicable and can be adapted to a variety of specific urban environments. Some are possible only due to new technologies while others apply technology to ideas that are as old as the city itself.

Within these innovations, four principles surface again and again. They can be seen as a core framework to find innovative solutions to complex urban problems:

Unleashing spare capacity: Many innovations cleverly make use of existing yet underutilized resources. Airbnb, for example, enables the renting out of unused private homes; co-locating schools and recreational facilities enables public-private sharing of space; and the circular economy provides opportunities to reuse, recycle and upcycle.

Cutting out the peaks: From electricity and water to roads and public transport, upwards of 20% of capacity sits idle for much of the time ready to cope with demand peaks; cutting out these peaks with technology-enabled demand management or innovative pricing structures can significantly limit the burden on financial and natural resources.

Small-scale infrastructure thinking: Cities will always need large-infrastructure projects, but sometimes small-scale infrastructure – from cycle lanes and bike sharing to the planting of trees for climate change adaptation – can also have a big impact on an urban area.

People-centred innovation: The best way to improve a city is by mobilizing its citizens. From smart traffic lights to garbage taxes, innovations in technology, services and governance are not ends in themselves but means to shape the behaviour and improve the lives of the city's inhabitants. All innovations should be centred on the citizen, adhering to the principles of universal design and usable by people of all ages and abilities.

¹ http://www.mckinsey.com/insights/urbanization/urban_world



1. (Digitally) Re-Programmable Space

Why

Demands on space in cities are constantly changing as a result of economic growth, demographics and consumer preferences. As urban populations increase from 4 billion to nearly 7 billion over the next 30 years, the world will need to almost double its urban capacity by 2050. There is neither the time nor money to produce the required infrastructure conventionally through large-scale engineering solutions; focus should be on the better use of existing infrastructure.

What

City centres struggled to adapt to the heavy, invasive technologies of the 20th century but can more easily host the clean, knowledge-based and lightweight industry and digital technologies of today. Cities have started to look at reprogramming their space to get more from less: Vancouver has reduced its allowable urban footprint; Glasgow has moved from a policy of expansion to concentration; New York has been incrementally repurposing asphalt to expand footpaths and open space; and Melbourne has repurposed 86 hectares of underutilized road and other spaces in the last 30 years and aligned new medium to high density residential development around its rail stations and road-based public transport networks.

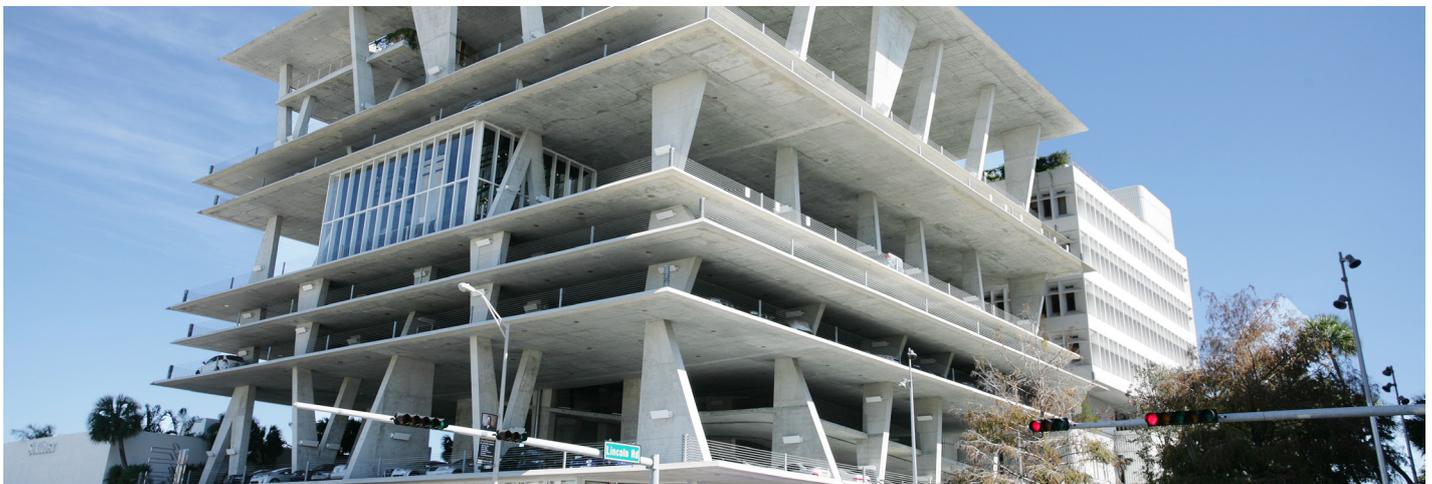
Potential

Melbourne's approach has helped reduce taxes from 13% in 1995 to just over 4%, and if it can accommodate the projected population increase of 3.5 million people by 2050 within its current boundaries, it will reduce required infrastructure funding by an estimated \$440 billion over 50 years. As such, treasured historic city centres could again become productive areas, hosting not only "knowledge workers", but also the emerging "fourth industrial revolution" of 3D printers and digital manufacturing, as technological development enables new ways of organizing work, occupation patterns and places of production. Buildings themselves will also be digitally programmable and able to instantly shift use between a theatre, gymnasium, social centre or night club, further minimising the overall urban footprint.

Useful links

<http://www.melbourne.vic.gov.au/ParksandActivities/Parks/Pages/ErrolStreet.aspx>

<https://www.melbourne.vic.gov.au/AboutMelbourne/Statistics/Documents/TransformingCitiesMay2010.pdf>



Picture 1. A multi-storey car park in Miami Beach also plays host to parties, yoga classes and weddings. The concrete building with floor slabs supported on wedge-shaped columns was completed in 2010 to offer naturally lit parking levels that can also be used for other activities above a row of shops and restaurants.



2. Waternet: An Internet of Pipes

Why

Population growth, ecological threats and climate change all make it more critical than ever to efficiently manage and protect limited freshwater resources. By 2030, it is estimated that freshwater demand could outpace supply by 40%. Currently, the average water loss due to leakage is estimated at 25-30%, with some utilities agencies allowing it to rise to over 50%.

What

Smart water management models use sensors in network pipes to monitor flow and manage the entire water cycle, providing sustainable water for human and ecological needs. Companies such as TaKaDu, based in Israel, are creating cloud-based solutions to connect water pipes to the Internet of Things, enabling a proactive approach to flood control and rainwater collection, and the identification of weak points or blockages in the network before major damage occurs. For example, in Queensland, Australia, Unitywater cut its direct water losses by one billion litres in one year, saving \$1.9 million; it reduced the time it took to detect and resolve network events by two-thirds, and increased availability by almost 20%.

Potential

Sensors in sewage pipes, using new techniques developed at MIT, could allow for scientists to analyse bacteria and viruses, monitoring the impact of health policies and more quickly detecting the outbreak and spread of infectious diseases such as flu strains. Such early warnings could help to prevent pandemics, saving lives and significantly reducing medical costs.

Useful links

www.takadu.com

<http://www.ch2m.com/corporate/water/water-resources>

<http://underworlds.mit.edu>



Picture 2. A team of MIT researchers, led by professors Carlo Ratti, Director of the Senseable City Lab in the Department of Urban Studies and Planning, and Eric Alm, Director of a laboratory in the Department of Biological Engineering, have developed a system to collect and analyse biochemical information from sewage water, what could be thought of as a “smart sewage platform”. The project, called Underworlds, is being tested in Cambridge, MA.



3. Adopt a Tree through Your Social Network

Why

The International Panel on Climate Change foresees an increase in extreme weather events that will challenge cities, especially in developing countries. The dominant engineering approach has been to build walls, bulkheads, levees and other fortifications to minimize the effects of future storms and sea level rises. A less appreciated response is planting more trees. Studies show that increasing a city's green area by 10% could compensate for the temperature increase caused by climate change: vegetation helps to block shortwave radiation while also evaporating water, cooling the ambient air and creating more comfortable microclimates. Tree canopies and root systems can also reduce stormwater flows and balance nutrient loads.

What

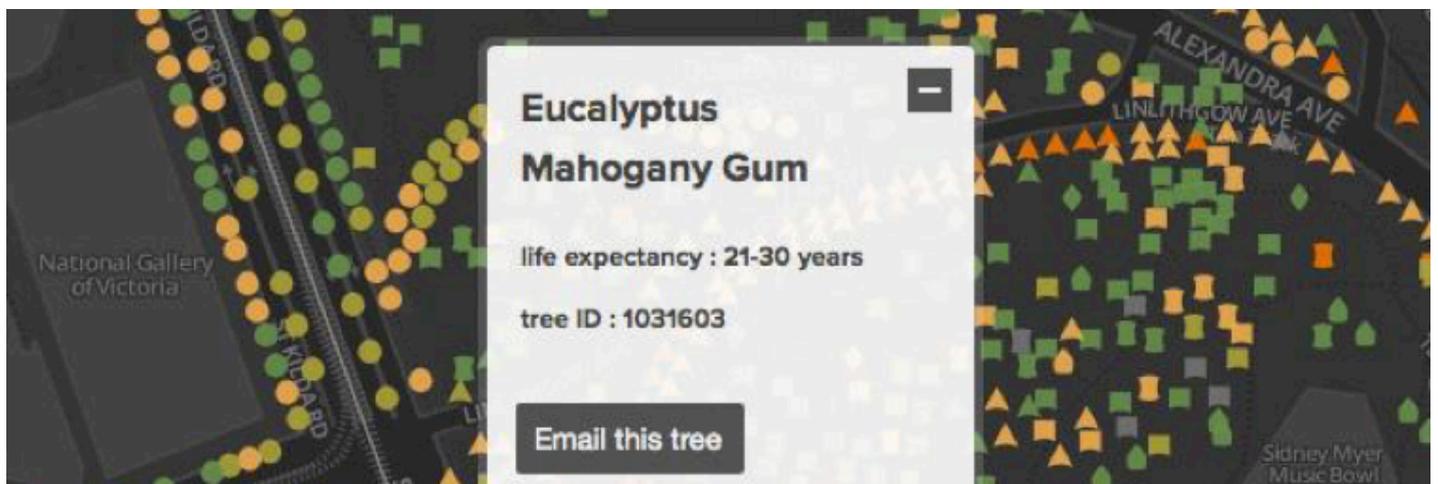
Melbourne encourages citizens to take pride in urban greenery through its Urban Forest Strategy, consisting of over 70,000 trees. All trees are tagged on a central database: citizens can adopt a tree, name it, track its growth and carbon offset and share this data through their social networks. Each tree has its own email address which allows citizens to report defects and diseases and even send love letters.

Potential

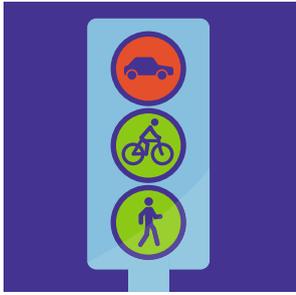
Trees now cover 22% of Melbourne, a figure that will rise to 40% by 2040. By developing tools and processes for measuring and modelling the potential of trees to mitigate the effects of climate change, Melbourne is positioning itself as a global leader in urban forestry.

Useful links

<http://www.melbourne.vic.gov.au/Sustainability/UrbanForest/Pages/About.aspx>
<http://www.rebuildbydesign.org>



Picture 3. Melbourne has developed a new website, [Urban Forest Visual](#), which details the location, genus and lifespan of the city's urban forest by precinct. The interactive tree map allows users to explore Melbourne's tree data, learn more about the life expectancy and diversity of trees in the city, and submit questions.



4. Augmented Humans: The Next Generation of Mobility

Why

Modernist visions from the 1920s and 1930s influenced the development of sprawling, tall, car-centric cities between freeways that spanned the world. These visions had no place for walking, cycling, public transport or well-planned, shared urban spaces that are human in scale, sustainable, healthy, safe and lively – elements that are now recognized as essential for cities to be environmentally sustainable, lively, equitable and liveable.

What

Improved safety for pedestrians and non-motorized transportation leads to greater adoption of public transport, reduced congestion and pollution, better health and commutes that are quicker (bicycles are, on average, 40% faster during peak hours), more predictable and less expensive. Small investments to encourage cycling can have a large payout, as high as 35:1 according to a recent [UK government study](#)¹. Such relatively low-cost solutions include separate bike lanes, bike-sharing schemes, re-phasing traffic lights to fit the speed of bikes and planting trees along the side of roads to slow traffic.

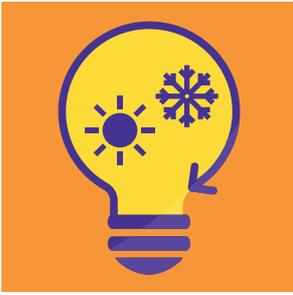
Potential

With advances in sensors, optics and embedded processors, a whole new breed of transportation solutions could emerge. For example, cycling could be further popularized by innovations such as the Copenhagen Wheel, an add-on to existing bikes conceived by the MIT Senseable City Lab that makes it easier to cycle by augmenting pedal power with a battery that captures energy as you brake or go downhill.

¹ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/348943/vfm-assessment-of-cycling-grants.pdf



Picture 4. The Copenhagen Wheel transforms your bicycle into a smart electric hybrid. The Wheel contains a motor, batteries, multiple sensors, wireless connectivity and an embedded control system. The Wheel learns how you pedal and integrates seamlessly with your motion, multiplying your pedal power.



5. Co-Co-Co: Co-generating, Co-heating, Co-cooling

Why

Around three-fifths of CO₂ emissions come from the generation of electricity, heat and industrial usage (IEA Statistics 2011). Due to factors including population growth, economic development, urbanization and industrialization, global energy consumption is projected to increase by around half from 2010 to 2035, reaching some 226 billion MWh (WEO 2010; EIA 2011). In the absence of technological breakthroughs, this increase in energy use will lead to a proportional increase in CO₂ emissions.

What

In conventional power plants, electricity generation produces wasted heat. “Cogeneration” mechanical systems capture and use the excess heat, significantly improving energy efficiency. Specifically, “trigeneration” systems use the heat either to heat buildings or to cool them, through absorption refrigerator technology – for example, cooling office complexes that house large numbers of computers. Trigeneration is making inroads into Scandinavia, southern Europe, South Korea and Japan.

Potential

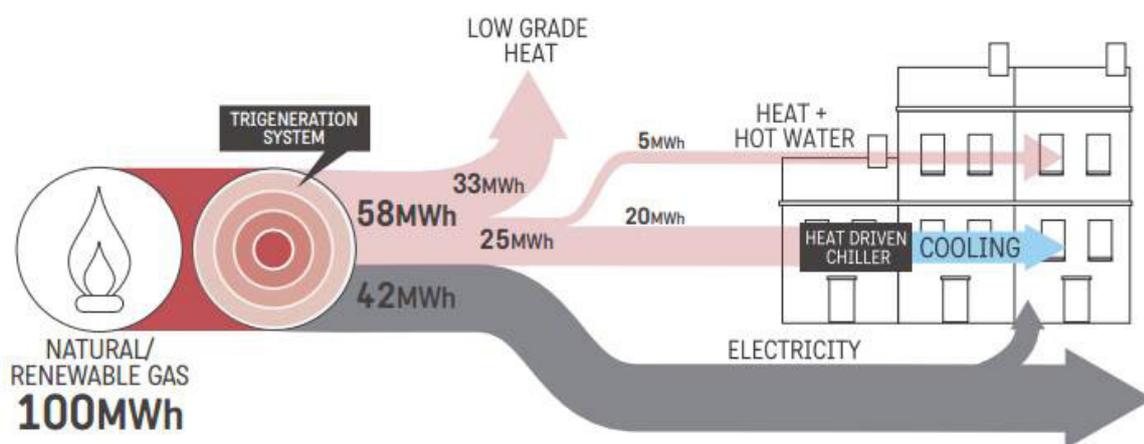
Quad generation goes one step further, also including the recovery of carbon dioxide from the generation of electricity and heat through burning gas. The CO₂ can be used in industrial processes, horticulture or the food industry, such as carbonating soft drinks. A quad generation setup offers operational flexibility, reduced operational cost and the potential for low or zero operational carbon emissions. The main challenge in such systems is the initial investment.

Useful links

<http://www.digital21.gov.hk>

<http://www.cisco.com/c/en/us/products/index.html>

http://www.cityofsydney.nsw.gov.au/__data/assets/pdf_file/0007/193057/Trigeneration-Master-Plan-Kinesis.pdf



Picture 5. Extracts from Sydney’s Trigeneration Masterplan. The project will contribute to Sustainable Sydney 2030 by reducing the city’s annual carbon emissions by 3% and reducing energy bills for Town Hall and Town Hall House by an average of 320,000 USD per year over the life of the project.



6. The Sharing City: Unleashing Spare Capacity

Why

Since the first Industrial Revolution, consumption patterns have tended to be linear – a “take, make, consume and dispose” economic model, which leads to intensive use of materials and energy. Moving towards a more circular economy will help to reduce resource use and emissions. The circular economy is closely linked to the idea of the sharing economy, in which the culture of consumption changes towards regarding products as service, ensuring they are used in the most efficient way.

What

Websites such as Airbnb make it easier for unused space to be rented out, reducing the amount of wasted capacity in terms of houses standing empty. Likewise, many city residents are reducing wasted capacity in commutes by using websites to carpool, or even ditching car ownership altogether in favour of web-facilitated car sharing clubs, which now exist in cities around the globe. Websites such as Streetbank make it easier for city residents to share other products, or pass them on when they are no longer being used.

Potential

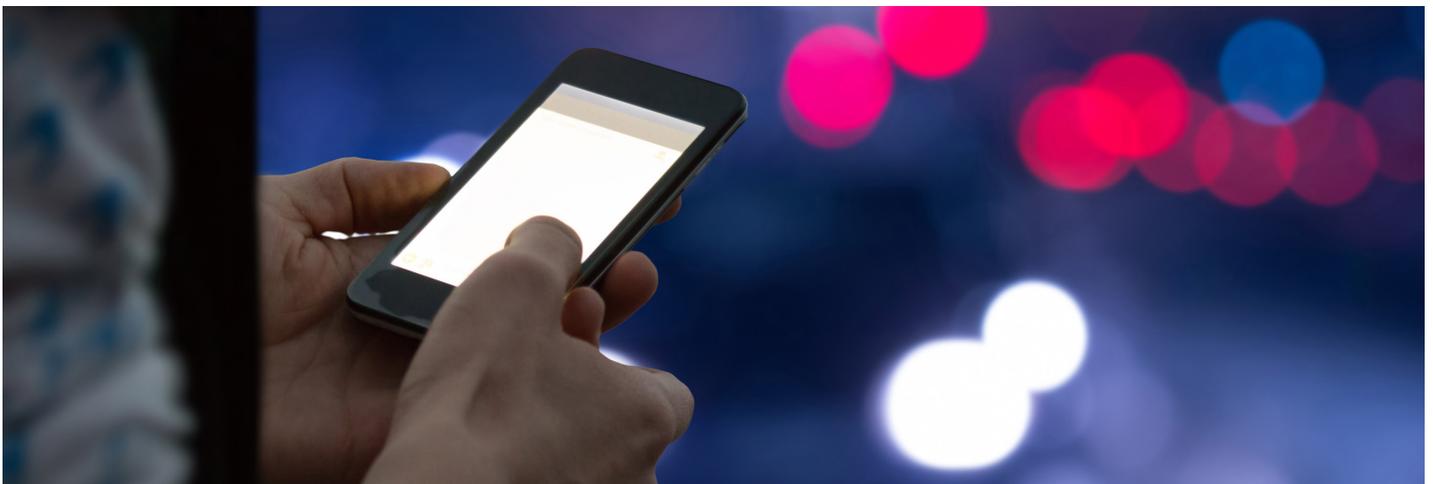
There are opportunities to expand the principle of sharing to the provision of physical, social and recreational infrastructure. Co-location reduces the need for infrastructure and enables more to be achieved with less resource use and at lower cost. For example, co-location of a new secondary school with a state sports park may enable gymnasium and other facilities to be shared and used more intensively; clustering child health services with schools may achieve better health and education outcomes; or land not being used by one government agency may be transferred and used more effectively by another.

Useful links

www.airbnb.com

www.streetbank.com

www.zipcar.com



Picture 6. The internet makes it much cheaper for individuals to offer traditional goods and services to a larger market. As websites such as Airbnb show, making it possible to connect with customers anywhere in the world cuts transaction costs and shrinks the advantage of scale that larger chains hold.



7. Mobility-on-Demand

Why

Vehicular traffic congestion – and the air pollution that results from it – comes at great monetary and human cost. In the 83 largest urban areas of the United States alone, the time and fuel wasted by congestion has been valued at 60 billion USD. The World Health Organization estimates that over one million deaths per year worldwide can be attributed to outdoor air pollution, in large part caused by vehicular traffic. Further fatalities are caused by road accidents.

What

Digital information and communication technologies could help manage vehicular traffic more efficiently. Real-time information allows unprecedented monitoring of urban mobility infrastructure, and opens up new potential for the exploitation of unused vehicle capacity through dynamic optimization algorithms. One example is the “mass transport vehicle routing” algorithm developed by researchers at Irvine University in California to route vehicles in real time, meeting demand for picking up and delivering passengers in fast-varying environments.

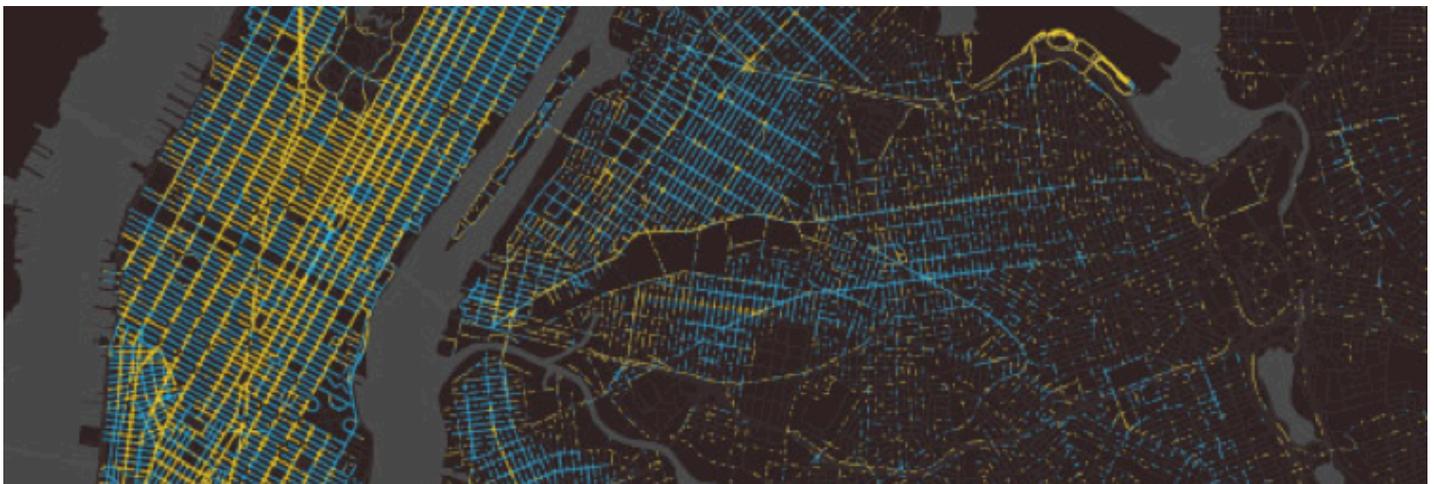
Potential

The increasingly widespread use of smartphones and their growing capabilities for running real-time applications will make it possible to design new, smarter transportation systems based on the sharing of cars or minivans. The on-demand qualities of individual mobility or taxis could effectively replace public transportation. Self-driving vehicles promise to have a dramatic impact on urban life, blurring the distinction between private and public modes of transportation. “Your” car could give you a lift to work in the morning and then, rather than sitting idle in a parking lot, give a lift to someone else in your family – or, for that matter, to anyone else in your neighborhood, social-media community, or city.

Useful links

<http://hubcab.org>

<http://www.uctc.net/papers/748.pdf>



Picture 7. A recent initiative by the MIT SENSEable City Lab in partnership with Audi and GE, HubCab analyses taxi trips to explore the benefits and impacts of vehicle sharing in New York City. The data was derived from the records of over 150 million trips made by 13,586 registered taxis in Manhattan during 2011 (HubCab, 2014). The GPS-enabled taxis reported on the geographic coordinates (longitude and latitude) and time of each trip's origin and destination, creating a map of pick-up and drop-off points.



8. Medellin Revisited: Infrastructure for Social Integration

Why

In 1992, Medellin, Colombia, was considered one of the most dangerous cities in the world. Today, it is seen as a laboratory of progressive architectural and urban interventions that were initiated under the mayoral administration of Sergio Fajardo (2003-2007). Whereas urban development projects often target specific solutions to physical problems, Medellin opted for a different strategy, using architecture and urbanism as tools for social integration.

What

Projects such as the España Library Park and the city's elevated cable car as a mode of public transportation have been presented as the key symbols of a process that has led to the city's spatial, social, economic and cultural transformation – connecting the city's low-income residents and communities with its wealthier commercial centre. As a result, Medellín has changed in the past 10 years, not just in its spatial dynamics but also in the mentality and perception of its inhabitants who now see culture as an important tool for development. This particular approach to urbanism has caught the attention of experts who have now come to see Medellín as an exemplar model in urban planning and governance.

Potential

Using architecture and urbanism as a tool for social development can bring surprising results in physical, functional and behavioural changes. In particular, the creation of new connections to break down city barriers between rich and poor can work as an instrument to contain and gradually eliminate violence in cities.

Useful links

<http://www.one.org/international/blog/why-residents-of-kibera-slum-are-rejecting-new-housing-plans>



Picture 8. Medellín's Metrocable was designed to improve transport and quality of life in informal settlements located on the mountainside, home to some of the city's most disadvantaged communities.



9. Smart Array: Intelligent Street Poles as a Platform for Urban Sensing

Why

Standard street lamps are expensive for municipalities to maintain and run, and in some cases contain toxic gases. Over the next few years, 4 billion lights worldwide will be converted to light-emitting diodes (LEDs), which last longer than ordinary street lights, consume less energy and contain fewer hazardous by-products.

What

Next-generation LED street lights can act as a platform for a host of sensing technologies that collect data on weather, pollution, seismic activity, the movement of traffic and people, and noise and air pollution. By linking these intelligent street poles into a network, it is possible to sense what is going on across a city in real time and provide innovative solutions in areas such as public safety or identifying where there are free parking spaces. One such system, the Light Sensory Network, was demonstrated by Cisco, Sensity and the City of Chicago during walking tours at the Internet of Things World Forum.

Potential

The switch to LED technology gives cities the opportunity to turn streetlights from a “dead asset”, which consumes energy and money, into a “live asset”, which produces revenues. How the technology is implemented will determine how the public receives it; transparency is key when it comes to public surveillance.

Useful links

www.sensity.com

<https://arrayofthings.github.io>



Picture 9. The Array of Things (AoT) is an urban sensing project, a network of interactive, modular sensor boxes that will be installed around Chicago to collect real-time data on the city’s environment, infrastructure, and activity for research and public use. AoT will essentially serve as a “fitness tracker” for the city, measuring factors that impact liveability in Chicago such as climate, air quality and noise.



10. Urban Farming: Vertical Vegetables

Why

The UN predicts the world's population will reach 9 billion by 2050, most of this extra 2 billion will live in cities, feeding all these new urban residents is going to require a complete rethink of the global food system. The current system is hugely wasteful. The Ellen McArthur Foundation found that 45% of perishable vegetables grown in Europe are wasted before they reach the table, much of this is due to long and inefficient supply chains.

What

A simple way to cut a lot of waste out of the system is to move the farm. The roofs of buildings and even the walls can use soil-less, hydroponic systems to grow food right on the consumer's doorstep. Hydroponic systems feed nutrients straight to the roots, using up to 10 times less water than traditional means. Advances in LED lights, which are now highly efficient and emit specific wavelengths for plant growth, mean that urban farms can be inside and stacked. Systems such as Aero Farms, stack multiple trays of veggies, yielding up to 100 times more per square meter than traditional farms.

Potential

Other companies such as Freight Farms upcycle shipping containers delivering a plug and play fully working urban farm all controlled from your smart phone. They can be placed in redundant space such as carparks and stacked, instantly scaling urban food production. Aquaponic systems used by companies such as Sky Greens take the waste products of fish farms to fertilize the plants, turning fish food into carp and lettuce. In the original design for London, an area of farmland was preserved around this city. This "green belt" was conceived as a way to preserve nature while ensuring food security for the burgeoning metropolis. The new wave of urban farming can be seen as a new vertical green belt feeding the populous while also bringing nature to the city centre.



Picture 10. Freight farming allows practically anyone to grow fresh produce inside of a standard 40'x8'x9.5' shipping container. Brad McNamara and Jon Friedman proposed the idea after realizing that the world needed a more efficient way to grow and receive food. The idea was originally to create farms on rooftop greenhouses; however, after running into several logistic issues, the two decided to change the scene of farming to shipping containers.
Photo by: Chris Rank/Bloomberg

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