Drivers of Change Cards full descriptions

Ageing infrastructure

Competition for land and ambitious carbon emissions reduction targets are only some of the factors that make retrofitting and the reuse of existing assets a key priority. This is especially relevant in developed cities where most current building stock will still be around in 2050. Investments in upgrades could ultimately result in cost savings. The need to invest more into inadequate and ageing infrastructure comes at a time when many governments are highly indebted and face competing demands for scarce resources. For many cities, this will mean an increased focus on boosting the capacity and lifetime of existing infrastructure.

Air Quality

The dangers of urban air pollution are increasingly apparent. With growing levels of urbanisations globally, the reduction and removal of airborne pollutants are becoming a critical challenge for national governments and city authorities.

Incorporated into the urban fabric, pollutant digesters can remove, filtering or transforming harmful airborne contaminants in order to improve air quality. If used within building facades, hard surfaces or installed as standalone mechanisms across the city, these help combat air pollution on an urban scale.

> *Industry examples: A scientist and an award-winning poet, both at the University of Sheffield, have made a giant poster that uses nanotechnology to gobble up pollution. It can absorb the poisonous compounds from around 20 cars each day if you put it by a busy road. Source*

Automation

Automation describes the automatic control of processes or operating equipment with minimal or reduced human intervention. Accelerated by technological advances it will play an increasing role in the delivery of tasks and services. Through faster turn-around time and reduced cost, automated tasks usually lead to an increase in productivity.

This will have implications for the shape of the industry and will lead to changes in the types of skills required and the role that engineers will play in the design and construction process.

Blockchain

Blockchain could affect the building industry through smart asset management, where a single distributed ledger would provide improved security and efficiency for a large number of assets and stakeholders involved. Blockchain could also speed up the adoption of smart grids with its ability to validate the authenticity and source of transactions, thereby helping users to better choose their suppliers. For large organisations, blockchain could substantially reduce the cost and time of transactions and ease international contracts.

> *Industry examples: Construction contracts and payments -Blockchain technology has the potential to affect both changes and facilitate this innovation. It can do so by shifting current payment and project management systems towards a more transparent and fair practice. By reducing late payments,*

remediations and disputes, small and medium enterprises are no longer placed in continuous cash flow risk. Instead, the industry as a whole can become a more trusted entity. Source

Corporate compliance

Corporate compliance outlines a set of policies and procedures designed to prevent and detect violations of applicable law, regulations and ethical standards by an organisations stakeholder. A growing global market, greater legal requirements and a changing regulatory landscape all contribute to an increasingly complex business environment: 2015 alone saw over 50,000 regulatory and compliance updates.

Increased investment in compliance operations is expected by 75% of boards in Europe, (US 60%, Middle East 80%), creating a culture of compliance and accountability is becoming a business priority.

Data analytics

Many organisations are already using big data techniques and advanced analytics to manage complex processes and supply chains. By providing decisionmakers with useful insights and information, data analytics can help improve asset management, risk management and interactions between customers and suppliers. Analytics can also identify areas that need improvement and opportunities for innovation with data on e.g. floor space, sunlight or energy performance informing an improved, data driven design and operation.

Data driven design

Parametricism is a style within contemporary architecture, which has been hailed as the successor to post-modern and modern architecture. Data Driven Design is a design practice where new projects emerge based on data inputs, such as floor space, sunlight, local weather and even energy performance, opening new levels of building performance and operation.

Design for disassembly

In the future, an increased focus will lie on design for disassembly, which takes into consideration both the construction and deconstruction process. Core principles include the initial selection of recyclable materials, the use of fewer material types, and preference of mechanical over chemical connections, which all lead to easier and more sustainable disassembly.

Industry example: Kengo Kuma's Jenga-like Cafe Kureon, the Pop-Up House by Multipod Studio and 'A Simple Factory Building' by Pencil Office, which features a pollution-filtering facade, aluminium window walls and reinforced concrete construction designed to be fully recycled at the end of its 33-year lease period. Source

Digital Fabrication

The development of 3D printing is expected to have a disruptive impact on the construction industry. The technology enables the production of purpose-built shapes that cannot be produced by any other method; it promises productivity gains of up to 80% for some applications, together with an important reduction in waste. Construction time for some buildings could shrink from weeks to hours, and customized components could be provided at much lower costs. However, within the current early stages of development, several issues persist, including resolution problems a trade-off between scale and speed and high costs.

Industry example: Keller AG Ziegeleien- This former industrial building, which is located in Munich, was recently re-purposed into offices, and was given an innovative new façade designed by Gramazio Kohler Architects of Zurich. The architectural firm made heavy use of an innovative robotic manufacturing process when creating this structure, which cost approximately $348,000 in American dollars to complete. *Source*

Digital Modelling

Advances in 3D modelling will enable the use of digital models to assist urban planning and design and construction processes. Digital models of planned buildings and infrastructure, incorporating time-based simulations (of population growth or weather events, for example), will allow decisionmakers to better understand the impact of projects and improve a city's environmental and social performance through scenario testing. The use of preliminary planning via 4D integrated scheduling and 5D cost simulations can help to eliminate potential complications before the construction process begins.

Industry examples: The 2012 London Olympic Stadium – Used to help ease information transfer between all group members and all disciplines. The BIM allowed all the individual models that had been developed by the design team to be brought together. Ultimately, the BIM provided means for the team members to visualize their work, including clarifying complex routing of services and de-risk parts of the project before the mechanical, electrical and plumbing contracts were involved. *Source*

Drones

Drones are rapidly being adopted by the built environment industry as a means to conduct site surveys, construct 3D models, and monitor, inspect and maintain infrastructure and buildings. Drones can perform tasks in terrain where it would be difficult for humans or require extensive preparation and risk management. According to research by PwC, the drone industry is estimated to reach a net value of US$127.3bn in 2020.

Industry examples: Builders use drones to collect real-time data about projects and understand what's happening on site. Aerial insights improve progress tracking and help catch problems early — before they become costly or add weeks to a project's timeline. *Source*

Intelligent buildings

Intelligent buildings are part of an increasingly integrated and smart built environment. Through a combination of new technologies and interconnected systems, buildings can become more energy and resource efficient, more secure, and more pleasant to work in. In the US, commercial businesses spend around US$100bn on energy annually, but greater use of intelligent building technology could reduce this cost by about US$25bn a year.

Intelligent transport systems

Intelligent Transport Systems (ITS) enable a smarter, more integrated system for moving passengers and freight. They allow transportation modes to communicate with each other and with the environment, paving the way for truly integrated and inter-modal transport solutions that maximise efficiency. For example, ITS could help reduce the congestion which cost the London economy around £5.4bn in 2013.

Internet of things

The rise of the Internet of Things - the connection of a huge range of devices, sensors, and machines to the internet - will enable city infrastructure to be designed and operated in a more integrated way. Currently, 99% of physical objects that may one day be part of this network are still unconnected. It is estimated that by 2020, 200bn objects will be part of the IoT (26 smart objects for every person on earth). The declining costs of sensors will allow more individuals to collect and analyse data about the urban environment.

Modular Construction

Modular construction methods can provide various benefits particularly to construction in urban areas. Entire buildings are 'manufactured' off site in transportable modules, complete with MEP services, fixtures and finishes. The building is then assembled on site, with users unable to determine where the modules are joined. Modular structures could expand easily and quickly to meet changing spatial requirements, enhancing a building's flexibility and adaptability. This method offers considerable reduction in cost, time on site, waste generated, and potential for recycling and reuse compared with traditional on-site construction methods.

> *Industry examples: Modular company Prefab Logic announced they would build a $102.5 million automatic volumetric modular construction factory known as Autovol in Idaho. The company says the factory could crank out at least 1,600 modules per year and it would aim to fix the affordable housing crisis on the West Coast with multiunit modular homes. Source*

Net zero design

Net Zero Energy Buildings produce as much energy as they use, and advances in construction technologies and renewable energy have driven an increase in the construction of highly efficient buildings. Yet only a small number are currently certified as fully Net Zero. Buildings use about 40% of the world's energy, with residential and commercial buildings using 60% of the world's electricity. Making buildings more energy efficient could result in substantial long-term benefits but also poses challenges, for example around necessary infrastructure upgrades for new sources of energy such as hydrogen.

> *Industry examples: The Phipps Centre for Sustainable Landscapes utilized an integrated design process and a two-part Action Plan to achieve a Net Zero Energy building. First, the team identified and incorporated energy efficient features to reduce annual energy usage by at least 50% in comparison to a traditionally designed building. By carefully coordinating energy needs with equipment size, the team also was able to reduce capacity requirements for HVAC systems and associated infrastructure (power, pipes, ductwork, pumps, etc.) by an estimated 30 - 40%. Second, the team provided on-site renewable energy generation to meet the remaining energy needs of the building. In addition to Net Zero Energy, the Centre achieves Net Zero water usage through an integrated system including rainwater harvesting, a planted roof, bioswales, and a constructed wetland. The Centre offers docent-led tours of the building highlighting the sustainability aspects. Source*

Offsite manufacturing

There is a growing trend for the manufacture of whole buildings and their component parts off site for permanent installation on the final site. There are advantages to this methodology for highly serviced areas, for example constructing bathroom pods sin a factory moves 30 trades off site, reducing the carbon footprint of the building and improving site safety.

Pre-fabrication can increase construction efficiency, enable better sequencing in the construction process and reduce weather related hold-ups.

> *Industry example: There are potentially huge gains to be made through using offsite manufacturing on nuclear sites. Working on the site itself can create delays (for example, waiting for security clearance for workers, or lorry deliveries) and problems can arise from limited access and space. Source*

Project Digitalisation

Digital service delivery is an increasing client requirement. Digitalisation leads to a much more granular understanding of components and performance, which enables new opportunities for planning, project management and real-time analytics. It also enables more transparent and flexible processes and the concept of 'lifecycle BIM', which has significant implications for the operation of buildings. The global market size for cloud computing services will reach US$555bn in 2020 (US$210bn in 2014). Research predicts that by 2017, the CMO will have overtaken the CIO in IT spending.

Robotics

Capable of working in all weather, with no need for rest, lunch breaks or sick days, robots could make 24hr construction more common, reducing project timelines and disruption. Some machines are reportedly capable of setting 1000 bricks an hour- roughly a home's exterior frame every two days or about 150 homes a year- 24 hours a day, 365 days a year. Robotics could also be utilised in dangerous conditions and drastically improve health and safety conditions for construction workers.

> *Industry example: Construction Robotics offers the MULE, or Material Unit Lift Enhancer. This robot can lift and place material weighing up to 135 pounds. The MULE picks up items straight from the pallet and the moves it to the location where you want it, carrying virtually all the weight and requiring minimal hands-on attention from your workers. Source*

Supply chain shape

The supply chain is increasingly becoming a focus of attention as a challenge but also an opportunity, e.g. as a source of employment, skill development and economic value. Within MEP engineering a trend towards earlier contractor involvement has been observed, and the digitalisation of the supply chain (such as BIM) combined with low-cost engineering capacity and India and South East Asia, is leading to greater outsourcing of specific engineering tasks and processes.

Value based services

The delivery of projects, products and services is increasingly 'performance based'. Here the focus is on delivering a certain outcome to the client (such as lower carbon emissions) rather than selling a product. The emphasis is on how something operates, rather than how it is designed, causing a shift in focus from capital expenditure to operational expenditure. This in turn has an impact on how projects are procured, commissioned and delivered. This trend will become increasingly relevant as performance monitoring through smart, integrated and networked sensing advances.