



# *Innovation Insight*

No 4.1/17 August 2017

## EXECUTIVE SUMMARY

### The impact of emerging technologies on the construction industry

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The focus of this report is on the impact of emerging technologies on the construction industry. The objective is to provide a wider overview, which can inform an encompassing discussion on the strategic business opportunities, risks and threats presented by emerging technologies and technological change on the industry. These insights can support decision making and underpin the development and implementation of corporate innovation strategies, informed by an assessment of companies' own technological capabilities and dependencies.

This report is not intended to be a historic review or an exhaustive discussion on the impact of technology and specifically emerging technologies, on the construction industry. Instead it discusses a *selected number of relevant and recent* developments. It is not intended to cover every individual reported use of an emerging technology in construction or all emerging technologies. A number of illustrative examples and cases highlight the implementation of specific major emerging technologies and their impact on construction. These are often signals of what is on the horizon, which will hopefully stimulate action and discussion.

An analysis of the technology-related impact, strategic opportunities, threats and risks also needs to account for a range of other factors, including the evolving economic climate and markets, industry structures, political developments and regulatory environments as well as social trends. Mindful of importance of these contexts, this report focuses on the technological aspects.

Reference to any company or product in this report does not in any way imply an endorsement or recommendation. None of the companies mentioned in this report contributed to funding of this study.

References to sources are provided in the full report.

#### **Previous editions of *DeltaHedron Innovation Insight***

- [Developments in emerging digital health technologies](#), No 1.2/17, April 2017
- [The impact of emerging technologies on the insurance industry](#), No 2/17, April 2017
- [People tracking technologies](#), No 3/17, May 2017

This document is the Executive Summary of the report 'The impact of emerging technologies on the construction industry' (August 2017). The full report can be downloaded from [www.deltahedron.co.uk/publications/](http://www.deltahedron.co.uk/publications/)

**DeltaHedron Ltd** is a UK-based business consulting firm with a global reach, specialising in the management of technological innovation. We support our clients with the development and implementation of innovation strategies, underpinned by an assessment of the impact, strategic business opportunities, risks and threats presented by emerging technologies and the dynamics of technological change.

We shall be delighted to discuss strategic business opportunities and risks, as well as the tracking and identification of emerging technologies, and innovation strategies to translate technological opportunities into business success.

Please contact us through our website: [www.deltahedron.co.uk](http://www.deltahedron.co.uk)

*DeltaHedron Innovation Insight* is a series of white papers, reports and newsletters exploring aspects of the technological future and technological innovation, with a specific focus on the strategic impact, business opportunities, risks and threats presented by emerging technologies and the dynamics of technological change

*‘Anticipating what can happen in the future is one thing,  
knowing what to do about it is quite another’*

## The impact of emerging technologies on the construction industry

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### Executive summary

#### Context

This report focuses on the impact of emerging technologies on the construction industry, with an emphasis on recent trends.

The vantage point of DeltaHedron’s approach is one of exploring the impact and the strategic business opportunities, risks and threats presented by emerging technologies and technological change. These insights support decision making and underpin the development and implementation of corporate innovation strategies, informed by an assessment of companies’ own technological capabilities and dependencies.

#### A strategically important industry

The construction industry is one of great strategic importance on the regional, national and global levels. Economic growth, quality of life, competitiveness and security all depend on new infrastructure and the maintenance of older structures. Construction is key to the success of

many other industries and sectors, and hence is also a political priority.

Globally, the construction industry is one of the largest industrial sectors, accounting for 13% of global GDP. Recent estimates indicate that it is worth circa \$10 trillion annually and that this will rise to \$14 trillion by 2025, with an expected growth of 3.6% per annum. Due to its size and the nature of its operations, the construction industry is a major employer, with circa 7% of workers globally working in construction.

#### An industry dogged by concerns

The construction industry is, however, also a troubled one and has been dogged by many concerns for some decades. The industry is characterised as being risk averse, resistant to change and not very innovative. Compared to other industries, construction exhibited alarmingly low productivity growth of only 1% over the last two decades. It is one of the least digitalised industries, with very low investment in R&D.

Waste, environmental friendliness and energy efficiency remain problematic.

The industry is experiencing labour shortages in a number of countries. This is not helped by the fact that safety is a concern, with relatively high mortality and injury rates. In the UK, the recent Farmer Review (October 2016) highlighted the construction industry's challenges, particularly with regard to the labour market.

The industry is also burdened by a number of structural problems, including the misalignment of interests and incentives of stakeholders, which is reflected in non-ideal approaches to contracting and risk-sharing. The industry is fragmented and not always transparent. Construction projects are increasing in complexity and size, yet inefficiencies in project management, logistics and procurement as well as execution persist.

There are some encouraging signs that this is changing, with innovative companies in the industry leading the charge. In general, however, there is cause for concern.

### **An industry ripe for disruption**

A number of forces are pressuring for change and there are calls for a 'reinvention of construction'. The construction industry is indeed ripe not just for change, but for a much more serious disruption.

A range of emerging technologies, including those which will enhance digitalisation and automation of the industry as well as new materials, will be catalysts for disruption. The emerging technologies will have a transformative impact on the industry and contribute towards addressing the challenges it faces. The disruption will, however, change the nature of the industry.

The disruption of an industry brings huge opportunities for those who seize them. This is true for the construction industry as well. A number of progressive companies in the industry are already riding the next wave. They have digitalised and are adopting innovative business practices and emerging technologies.

At the same time, the impact of the emerging technologies also pose risks and threats for industry laggards who fumble the future. This is not a time for companies in the construction industry, governments for that matter or those who are considering entering the industry, to be complacent.

Following a disruption, it is also not uncommon for the industry hierarchy to change, with new companies emerging as industry leaders.

As is often the case when industries are disrupted, there will also be successful new entrants. The new entrants will leverage new technologies and typically also bring new organisational cultures and industry dynamics, new business models and new best-practices, some of which were developed in other industries. In fact, some of the new entrants will no doubt come from other sectors – such as manufacturing.

'Constructech' start-ups, analogous to the fintechs and insurtechs which are disrupting the financial and insurance industries, will also contribute to the disruption of construction and fill industry niches where they have competitive advantages.

### **Embracing innovation**

The construction industry's general risk averseness resistance to change and 'lack of innovativeness', is fundamental to many of its other woes.

The key is for the construction industry, as well as individual companies, to embrace innovation in its broadest sense. An innovation mindset and culture must be developed and the quest for innovation and the 'innovation premium' should be fundamental objectives.

Technological innovation is important, but it should be blended with other types of innovation such as business model and organisational innovation to achieve ultimate business success.

Equally important is the recognition of the importance of different innovation modes. Relying only on incremental innovations is a flawed strategy. They are important elements to achieve continuous improvement, but this should not become a comfort zone or a cover for resistance to fundamental change when that becomes necessary. The impact of incremental innovations have a tendency to run their course, and their further pursuit then becomes one of diminishing returns. Very often this is the time when radical and disruptions are required to bring renewal and stimulate growth. The construction industry seems to have reached that point.

### **Technology-related trends**

A number of trends in the construction industry are technology-related, either driven to a large extent by digitalisation and other emerging technologies, or impacted by technology. These include the trend towards a sensitivity for the

environment and eco-friendliness, energy efficiency and renewable energy sources. Conservation of natural resources and reducing carbon emissions will stimulate the 'greening of construction'. This will have an impact on the design of buildings and the way in which they are used, as well as on the construction process.

Smart buildings and infrastructure of the future will be 'intelligent' and engage actively and proactively in and with their environment, and with the humans and animals in the environment. They will have the ability to sense the status of and changes in their environment, make decisions, intervene and respond, and communicate with people, other buildings and devices; and increasingly anticipate, learn and adapt their behaviour.

The design of smart buildings need to be future-proofed. The electronics and sensors which provide the intelligence for smart buildings evolve very fast, and a building will probably accommodate several generations of electronic devices.

### **The impact of emerging technologies**

A number of emerging technologies are collectively driving change in the construction industry. They will have a transformative impact on the industry and contribute towards addressing the challenges it faces.

#### **Digital transformation and digitalisation**

Digital transformation is one of the most significant global trends. It impacts every sector of society, driving progress, economic growth and quality of life. No industry is left untouched.

The construction sector has exhibited very little productivity growth during the last two decades. Mindful that there is a direct correlation between the extent to which an industry is digitalised and productivity growth, it is not surprising to note that construction is one of the least digitalised industries.

Digitalisation of the construction industry is one of the forces which will accelerate disruption. Digital-related technologies such as mobile and cloud-based applications will underpin a number of other emerging digital and data technologies. These will in turn enhance the quality of data driven decision making and productivity.

As part of the digitalisation process, the construction industry will increasingly adopt practices which are common cause in other

industries, such as software-as-a-service (SaaS), Enterprise Resource Planning (ERP) and bring-your-own-device (BYOD). Emerging data technologies such as big data, analytics, machine learning and artificial intelligence (AI) all have application in the construction industry, and will multiply the impact of digital transformation as they have done in other industries; as will virtual reality (VR) and augmented reality (AR), Building Information Modelling (BIM), the Internet of Things (IoT), geolocation and blockchain.

Collectively, digital emerging technologies will enhance logistics, supply chains and procurement. An interesting development is the emergence of digital markets in building materials, in which constructechs have taken the lead; similarly, for the market for peer-to-peer rental of equipment, which is enabled by data sharing platforms.

Increased digitalisation brings with it greater cyber security risks, posed not only by viruses, malware and ransomware which can disable and disrupt systems, but also criminal cyber activity which include the theft of commercially sensitive and personal data. These breaches carry significant legal, financial, reputation and operational risks.

#### **Automation technologies**

A number of emerging technologies are contributing to the automation of construction, lending weight to the notion of 'construction as a production process'. They will contribute significantly to productivity enhancement.

3D printing is finding increasing applications in construction, including the printing of parts and models but also modular panels and even entire buildings. There are many reports of buildings being 3D printed in a matter of days. This is often combined with modularisation and off-site manufacturing, which are important trends in own right. Large 3D printers specifically designed for construction use a technique known as 'contour crafting', with cement as the 'ink'.

Robotics is also set to impact on construction, ranging from robots involved in site preparation and waste clearance to brick laying and welding.

Drones and autonomous vehicles have many construction applications. They can be fitted with a range of image, video and related sensors. This enables them to conduct aerial mappings and surveys, safety inspections as well as recordings of project progress. In addition, they also find application in data relay, site security and safety.

Wearables refer to textiles and other devices worn by a person, which can send (and receive) information gained from IoT sensors. The information can reflect the person's physical and emotional state, movement or position as well as other environmental variables.

### **New materials**

By their very nature, new builds and retrofitting consume vast amounts of construction materials. Trends in materials of the future will redefine how projects are conceptualised, designed and executed as well as the life cycle trajectories of the projects. Given the large volumes concerned, even small improvements in performance can have significant impact productivity, durability and safety; and similarly for reductions in cost.

Concrete and steel remain widely used, with work continuing to improve the performance of both. Recent advances have seen the emergence of lighter, more flexible and versatile forms of concrete, including self-consolidating, self-healing and self-compacting concrete.

A number of innovative alternative materials with promising construction applications are emerging. These include, for example, ETFE which is 99% lighter and also stronger, eco-friendlier, better at light transmission and more flexible than glass; permeable concrete replacements which can absorb significant amounts of water as well as insulating materials and adhesives. Kinetic materials have the ability to convert movement to energy, and can be used in flooring and roads.

There are signs of a resurgence in the use of wood an timber, fuelled by the emergence of cross laminated timber (CLT) panels and related products. CLT panels are strong, light and durable, and their use has been approved for use in high rise buildings.

Following the Grenfell Tower fire tragedy in London in June 2017, there will be a renewed focus on the use (or not) of cladding and fire retardant materials as well as building codes, planning and inspection to prevent and contain fires.

Green construction materials will no doubt become increasingly prevalent, driven in part by regulations, demand from customers who are more environmentally sensitive as well as economic benefits. We will probably also see the need for suppliers of green construction materials to prove that the materials have been procured from green and eco-friendly sources, in a manner

similar to which there is a requirement for consumer products to be ethically sourced. These may be tied to existing green credentials such as BREEAM and LEED.

### **Workforce, skills, training and education**

A number of countries are experiencing labour shortages in construction, including the UK, US and Australia. It is also not easy to attract new talent. The global financial crash of a decade ago is still reverberating, but the industry's image, safety record and other challenges are not helpful either.

Disruption of the construction industry will necessarily have an impact on the labour market, driven in part by the emerging technologies and the dynamics of technological change.

As new technologies emerge, the nature of work and jobs change. It is typical for disrupted industries to experience technology-related labour upheavals, particularly during transitional periods. New types of jobs requiring new types of skills emerge. As mature technologies become obsolete, the jobs and skills they require, phase out.

The construction industry desperately needs to improve its productivity. This will provide further impetus for the increasing prominence of productivity enhancing technologies and practices, such as offsite modular construction, 3D printing, robotics and drones. The adoption of these technologies will lessen the demand for some skills currently required in construction, but will also precipitate the creation of new jobs, requiring new skills.

The use of data driven technologies such as big data, analytics and artificial intelligence will similarly also change the nature of work in construction-related professions such as architecture, quantity surveying, building management and to an extent also structural engineering.

The next generation of construction workforce will work in a industry which differs in many respects from the industry we know today. Many of the young people entering the industry will be 'digital natives', who will naturally accept, if not demand, digitalisation. They need to be prepared for the new types of jobs which will be required in the new digitalised and automated construction world – many of which do not even exist today.

Universities and other training institutions need to embrace the emerging new technological regime in construction. They need to focus research and

enterprise on the development and enhancement of the new technologies and related business practices and ensure that their curricula are designed to train constructors who can create the future. Perhaps we should also consider the notion of disruption when thinking about construction education.

It is also necessary to ensure that the current workforce understands the new technologies and the benefits and opportunities they bring; as well as the risks and threats of ignoring them. Senior decision-makers in particular need to take note – it is very much in their gift to embrace innovation and benefit from the innovation premium, and to adopt emerging technologies and lead the disruption charge.

The question is not so much, “what will it cost?”, but rather “what will it cost if we don’t do it?”.

### Recommendations

From a strategy viewpoint, decision-makers in construction companies as well as governments need to consider the broader evolving landscape and the drivers which will contribute to the disruption of the construction industry.

The impact of emerging technologies is only one of those drivers, albeit a very important one. They will be catalysts and accelerators for change.

It is important for companies to recognise the strategic importance of a structured approach to the management of innovation, particularly technological innovation. An innovation strategy should be an integral part of the corporate strategic plan.

The dynamics of technological change will always impact on the fortunes of companies and countries. Emerging technologies will continue to substitute and replace mature technologies, and disrupt industries.

Companies should consider the importance of formally assessing their ‘technology dependencies’ as part of the risk management process. They should gain an understanding of which technologies they critically depend on and rely, whether it be technologies which constitute their (current) competitive advantages, underlie the products they make, services they render, are used in their operations or on which their logistics and supply chain and customers rely.

Assessing the impact and the strategic business opportunities, risks and threats presented by emerging technologies and the dynamics of technological change should be integral elements of the innovation strategy in the construction industry.

Does your company have an innovation strategy – and if so, can you describe it and determine whether it is working? If not, do you sometimes find yourself wondering what happened... not even to speak of what can happen and which interventions should be made to shape the future?

## Appendix: 'Instead of trying to see the future, start making it'

Published in *New Statesman*, 'Spotlight on emerging technologies', July 2017

6

# Instead of trying to see the future, start making it

**Dr Calie Pistorius, chief executive of DeltaHedron, says that companies must stay abreast of the latest technologies in order to remain competitive**

**A**nticipating an actionable future enables a proactive shaping of the future, rather than merely reacting to a world predetermined by others. The fate and fortunes of companies, irrespective of the business they are in, are closely linked to the technologies on which they rely to conduct their business.

It is the dynamics of technological change, whether incrementally or disruptive, in products, processes and services, which drive innovation and progress. Emerging technologies present great opportunities, but also strategic business risks and threats to companies' and industries' products, operations, supply chains, logistics, business and manufacturing processes. The strategic business risk here is as much about failing to exploit the opportunities as it is about the threat of an adverse event.

Technologies are continuously being improved, leading to "better, faster and cheaper". At the same time "last year's hot model" becomes obsolete. Some technologies evolve at a gentle and incremental pace, whereas others change rapidly. From time to time the technological, business and societal landscapes are disrupted by radical innovations, often coming from unexpected and different industries to the one in which they impact.

The disruptions typically result from the interaction of a combination of emerging technologies blending with innovations from other fields, be it finance, fashion or fitness. Many emerging technologies are IT-based, including big data and analytics.

However, the disruption can just as easily come from new materials, drones, robotics, 3D printing, virtual and augmented reality, biometrics or the Internet of Things.

Technological innovations spawn new opportunities, jobs and careers, business models, companies and industries; new ways of doing things and new sources of prosperity. When a new technological order is established, expect the industry hierarchy to change. New companies, in fact new types of companies, become the new industry leaders, often those that had no position in the old technology. The "wave of creative destruction" tends to destroy the established structure, triggering the demise of old technologies, labour markets, jobs and skills and eventually also companies and industries based on the old and obsolete technologies.

There are many examples of those who have created successful new futures underpinned by new technologies. Similarly, there are many who have perished whilst fumbling the future, who have been in denial and steadfastly clung to the obsolete, ignored the precursor indicators signalled by emerging technologies or deployed ineffective innovation strategies to deal with them. It is not unusual to find that their organisational cultures just could not embrace the technological change, often causing the transition to a new technology to, if it made, to be bungled.

Anticipating what can happen in the future is one thing, knowing what to do about it is quite another. As is the case with all business risks, the process of technological innovation and the associated opportunities and strategic business risks – especially those presented by emerging technologies – should be managed, and managed within the context of an innovation strategy which is an integral part of the corporate strategy. Vigilant and continuous tracking of emerging technologies and assessing their impact are essential elements of this process.

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## Notes



DeltaHedron's business offices are located in the **Centre for Digital Innovation (C4DI)** - a vibrant private technology business incubator located in the centre of Hull.

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No 4.1/17 August 2017



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