Disruption is Coming to the Building Industry

By Steven Burrows, CBE, P.E., FICE, FASCE, MIStructE, LEED-AP

The construction industry is on the cusp of significant disruption that will forever change how buildings are bought, designed, made, and assembled. The summation of the technological forces being applied to the construction industry is termed PropTech.

PropTech investment in 2016, according to Re:Tech, was a record at $4.2 billion which tripled to $12.6 billion in 2017. Data from 2018 is expected to outstrip 2017 easily. The reason is that construction employs 7% of the world's working population and around 50% of manhours on construction sites goes towards unproductive tasks. Construction also has the lowest digitization index, a measure of technological adoption, of any major industry, creating a target for PropTech. The rewards for success are therefore huge and investment capital across the world understands that.

Buildings have also become unaffordable, with the cost of construction outstripping the consumer price index by a significant margin in major economy in the world. This can be seen in major cities by looking at increased commute times or by comparing the average wage to the average cost of housing. By all measures, this trend must reverse to be sustainable.

The concept of technology disrupting established high cost/low productivity industries is not new. Airbnb disrupted the hospitality industry in 2008, Uber did the same to taxis in 2009, Amazon has disrupted retail, and WeWork has disrupted the workplace. Their rewards have been huge, with Airbnb now valued at $25 billion and Uber at $50 billion in sectors that have revenues that are a mere fraction of those in construction.

The AEC industry is seen as the last major industry to be disrupted. Investment dollars are a sure sign that change is coming, and it is coming fast. Some examples, just in the last months, include PlanGrid (formed just 7 years ago) sold for $875M, Building Connected founded in 2012 and sold in 2018 for $275M, and Katerra formed in 2015 and now employing over 5,000 people. There are hundreds of examples of new players entering the AEC space all with one goal in mind, to increase cost effectiveness and disrupt the status quo.

What are Investors Seeking?

McKinsey reported in *Reinventing Construction* that the global productivity gap between construction and the average for other industries equates to $1.6 trillion per annum. That would require construction to increase overall productivity by around 50% to align with the average for all industries.

Improvement is predicted to come from five big moves (and their share of the productivity increase):

1) Collaboration 7.5%
2) Design 10%
3) Supply chain 7.5%
4) Onsite execution 10%
5) Technology 15%

Technology underpins the changes that are coming but, to understand how such a major move can be made, it is worth looking at other industries that have been transformed such as automotive, shipbuilding, or aerospace.

In the automotive industry, cars have broadly maintained the same relative price over the last 50 years, meaning that, in terms of 2018 dollars, a car in 1960 costs about the same as one today. However, that car is now considerably more advanced, of higher quality, and far greater reliability than in 1960. By way of comparison, homes cost around double what they cost in 1960, in present-day dollars. However, buildings are not significantly more advanced now than they were 100 years ago. They still use wood and nails, doors still use keys invented in 1860, and the loss of the artisan tradesman to the journeymen means they have not improved in terms of quality, life expectancy, or reliability. At a different scale, we marvel at the speed of construction of the Empire State Building and cannot replicate it today while using substantially the same structural materials used for the last 100 years. To build better, cheaper, and faster requires a transformation and that is what PropTech intends to achieve.

Shipbuilding is another excellent example of the type of transformation that can be expected to occur in the AEC industry. The world's largest vessels are around 1,500 feet long. These massive structures were mostly stick built in shipyards 30 years ago. Unlike the car, the scale of these ships is such that their length would put them alongside the world's top 20 tallest buildings. In shipbuilding, the industry moved to offsite construction. Today, ships are made of assemblies of huge modular components largely factory built and then merely connected at the shipyard like giant Lego® blocks.

Aerospace used to build passenger aircraft in one place. It became the first major industry to standardize using a common modeling protocol to create a single coordinated source of truth. This decision allowed suppliers anywhere in the world to make standard components that fit in the model and sell those components for multiple buyers, effectively creating a global supply chain model. The automotive industry followed that approach. Now, many cars are built on the same chassis with the same drivetrains but produced by assorted brands. Can buildings be created that way, instead of each building being bought out on a one-off basis?

The benefits to these approaches being applied to the AEC industry will lower cost, increase speed, and improve quality. Investment is bringing these thought processes to the AEC industry at the speed Uber arrived on the scene to rival taxicabs.

The AEC industry has long argued that the unique nature of the product, together with the fragmented nature of the market, prevents this revolution occurring. However, technology thrives on complexity. The time taken to reach 50 million users for the radio was 75 years, television did it in 13 years, the Internet took just 4 years, but PokemonGo did it in 19 days. Technology now enables us to deal with complexity at a speed never before possible. We now use smart devices that allow apps to be developed anywhere by anyone; Tesla is using that same approach to communicate with its cars. The age of technology disrupting the AEC industry is here.

Where is the Investment Money Going?

Investment into AEC has been going into 10 primary places:

1) Offsite manufacturing
2) New building materials
3) 3-D printing and additive manufacturing
4) Autonomous construction
5) Visualization
6) Data and analytics
7) Wireless connectivity
8) Collaboration tools
9) Scanning and sensors
10) Building Information Modelling (BIM)

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Several new companies have also emerged, as have alliances between manufacturers and constructors. The competitive landscape is changing as is the process for buying buildings. The way customers will interface with building providers will be more like buying a car online.

Some of these changes were inevitable; for example, automation on site. Autonomous cranes, dirt scrapers, bricklayers, drywall finishers, and other trades are obvious candidates, as there is insufficiently trained labor to meet demand. Automation simply closes the labor gap.

For other parts of the supply chain, the impact will be more than just lost jobs; engineering is one of them.

The Professional Engineer 2.0

The author firmly believes that now is the greatest time in history to be an engineer. There have been several other great times such as in ancient Egypt, Rome, or during the industrial revolution, but today is the best of them all. The disruption to AEC gives the engineer the greatest opportunity for transformation.

The engineering profession needs to take advantage of these three opportunities:

1) Designers must design for constructability much as the ancient engineers did in Egypt and Rome.
2) Designers must design for manufacturing so that the deliverable is not a construction drawing but machine code that can go straight to the toolset.
3) Designers must design for whole life cost, understanding maintenance and how to replace elements of buildings to allow them to be renovated easily.

Designing for Constructability

For most of history, engineers determined the means and methods by which buildings were built. The engineer had to understand how technology impacted the design in order to design it. Tomorrow's AEC industry will be much the same; as manufactured modules, components, and assemblies become the building blocks of tomorrow's buildings, so will the engineer need to understand how automated systems on construction sites will place these blocks within the building. Process engineering will sit alongside structural engineering as a design discipline, and the separation of engineer and builder will blur if not disappear.

In recent years, engineers have increasingly relied upon pre-construction services from contractors to de-mystify the logistics of building. However, in a future where vertically integrated firms manufacture the majority of parts and pieces offsite, engineers will need to look to the ways of the past to determine how assemblies will be put together.

Designing for Manufacturing

Designing for manufacturing will also bring a need for change. Today's engineers deliver documents that are sufficient for permitting, and for contractors to tender and complete the design and deliver it back for review via shop drawings. In a world in which the engineering product is a machine file sent directly to manufacturing, the role of the engineer will become one of designer-maker. Shop drawings will disappear. The product of an engineering design office will be a single coordinated model from which components can be extracted in the form the factory needs it. No more will there be many versions of the building in models held by architects, engineers, subcontractors, and general contractors. There will be just one coordinated source of truth, a model not just used for gaining a permit but a model that is manufacture-ready.

Engineers need to step into the world of product design, understand the capabilities and needs of equipment, and coordinate the components that make up the building systems as a set that fits together as one.

Designing for Whole Life Cost

The cost of a building has 3 parts: the first cost, the operational cost, and the personnel cost. The ratio of these is 2:6:92, yet today we almost exclusively focus on the first 2%.

Taking the first cost; building construction tolerances are poor and lack of accuracy is far below that in industries where manufacturing methodologies are used to create the product. In construction, these tolerances and lack of fit are remedied by many means such as shims, welds, wedges, caulking, sealants, cover strips, or finishes. All these things add unnecessary cost that high-quality construction would require less of, or in some cases will just not be needed. Manufacturing demands that tolerances are tighter to make it efficient. Quality of construction has to improve.

Operational costs also have to come front and center. Buildings built as a series of components will have the ability to unplug these elements for renovation. Today we see small examples of this in items such as bathroom pods. However, disaggregation based on life expectancy will soon be a key design consideration. Additionally, the life-to-first-maintenance and the means of doing this will become the responsibility of the designer.

Engineering decisions around material compatibility, tolerances, maintenance, and lifespan impact the cost the customer pays. Engineers will need to take a leading role in this for the transformed industry, as design decisions will need to be made holistically.

How will engineers take on all this additional work and responsibility? The answer is design automation. Many designers have 30% or more of their staff undertaking routine tasks that algorithms will replace. Studies suggest that one-third of the entire U.S. workforce will need to find new occupations by 2030 as automation comes to the AEC industry, creating a lower ratio of staff headcount to fee revenue. This will create space for these changes to occur at no cost to the project.

Too Much, Too Soon?

In a transformed industry, where buildings will be built twice as fast for half the cost and at much higher quality, the role of the engineer is going to be key.

The future will be data-driven, automated, and component based. Now is the most significant time in history to be an engineer in AEC, but the profession must change to meet these demands.

The great news is that many disruptive firms in PropTech are led by engineers who already see the opportunities that lie ahead. However, many consultants are only now beginning to consider the impact of change. Some firms are investing in parametric capabilities, allowing staff to go back to school to learn how to script code and attend manufacturing conferences to understand the tools being developed and the potential of new products. Some of these firms are late to the changes, but not too late. If we remain alive to the possibilities and stay open-minded, not passive, then we should be able to play a crucial part in tomorrow's disrupted industry.

So my message is this: Change is coming, and it is coming fast, so get your business future ready.

To do this, you need to do four things:

1) Change your mindset and be open to the possibilities.
2) Consider the future, not as a destination but a place of disruption.
3) Prepare yourself for a range of scenarios; stay current and relevant.
4) Invest in your people, your processes, and your future.

It is an incredibly exciting time to be in the AEC industry.▪

Steve Burrows was a Director of Arup, EVP at WSP, and Executive at Katerra. He is now a Principal Consultant at Cameron MacAllister Group and a Founding Partner of Baumatix Building Automation. (*burrows@cameronmacallister.com*)