

Session Theme: Engineering Services

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Topic: Consulting Engineering in the face of disruptive technology

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Background:

Throughout history we have underestimated the power of technology to change our world. The exponential growth in technological change impacts industries and professions and questions their future existence in its current form.

The possibilities of billions of people connected by mobile devices, with unprecedented processing power, storage capacity, and access to knowledge, are unlimited.

Already, artificial intelligence is all around us, from self-driving cars and drones to virtual assistants. Engineers, designers, and architects are combining computational design, additive manufacturing, materials engineering, and synthetic biology to pioneer a symbiosis between microorganisms, our bodies, the products we consume, and even the buildings we inhabit.

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Professor Clayton Christensen, of the Harvard Business School, describes the power of *Disruptive Technology* whereby a smaller company with fewer resources can successfully challenge established businesses. This happens as a big established business focuses on improving their products and services, typically for their most demanding and profitable customers, thereby exceeding the needs of some segments and completely ignoring the needs of others. Disruptive entrants to a market begin by targeting those overlooked segments, and make inroads to delivering the same (or better) products at a lower price. Big established business, focuses on higher profitability in more demanding segments. Whereas new small business entrants can move upmarket, and rival the performance that big established businesses' mainstream customers require, all whilst maintaining the advantages that drove their early

success. It is when mainstream customers show preference for the new entrants and start adopting the new entrants' offerings in volume, that disruption occurs. Often, when new competitors with new business models arrive, big established business chooses to ignore them. Through clever development, growth and/or exposure, a disrupter whose product or service was once inferior, soon achieves a level of quality acceptable to the broad middle of the market, undermining the position of long time market leaders. This leaves a reduced market share for those practicing with unchanged business models.

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The acceleration of innovation and the velocity of disruption are hard to anticipate. New technologies create new ways of serving existing needs, and significantly disrupt existing industry value chains. Disruption is also flowing from innovative competitors who, can oust well-established businesses faster by improving the quality, speed, or price at which value is delivered. There are also major shifts on the demand side, such as growing transparency, consumer engagement, and new patterns of consumer behaviour that force companies to adapt the way they design, market, and deliver products and services.

The most surprising thing about disruption is that almost all successful attacks originate from industries which formerly had nothing to do with the business sector they are now revolutionising: We can call this business unusual. The largest telecoms service (Skype) was not invented in the telecommunications industry. The world's fastest growing financial services provider (Society One) is not a bank and neither is Paypal. The world's most valuable retailer (Alibaba) does not have any inventory, just like the largest taxi company in the world (Uber) owns no taxis and the largest accommodation provider (Airbnb) owns no real estate. It is just as Peter Thiel state in his book "Zero to One" – "Every moment in business happens only once – the next Bill Gates will not build and operating system. And the next Mark Zuckerberg won't create a social network. If you are copying from these guys, you aren't learning from them."

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What do previously world-renowned brands Kodak and Blockbuster Video have in common? They have all suffered a lack of innovation and effective

leadership and although they used to be massive in their time, they refused to change:

Blockbuster was a hugely popular DVD rental business. It failed to embrace innovation and buy Netflix in the year 2000. Blockbuster lost their position in the market due to the inability to innovate. They didn't recognise the advantage of innovative ideas, or the scale of the future of online streaming, and went out of business in 2013. Whilst Netflix is the most popular choice for watching a movie at home.

Kodak – In the 1970s', Kodak enjoyed over 80% of camera sales and 90% of film sales and created the market for cameras and films globally. Kodak *knew* about digital photography; it invented it! Steve Sasson, the Kodak engineer who created the first digital camera in 1975, described the management response to his development was, “That's cute — but don't tell anyone about it.” So Kodak's leaders were aware, but in denial. By 2012, Kodak filed for bankruptcy that marked the end of the once famous brand.

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So these failures demonstrate, that despite a company's management feeling confident that they know the general direction that technology is heading – the mistake made is that they do nothing about it. History has taught us that when a disruptive technology appears on the horizon of our industry, we need to ask ourselves, “How open-minded are our company's leaders?” and “What voices are the executive management team willing to listen to?”

Sustaining the business dependent on renewal of and within the organization. In consulting engineering, innovation is not only related to technology it is also related to the renewal of processes in a timely and cost effective manner with quality at the forefront of what we deliver.

To this end, **Xerox** is a fascinating business case. At end of the 1990's was worth \$64 a share and by 2001, dropped to \$7 a share. What makes Xerox unique, is that it created and backed one of the most innovative teams in history, yet it failed because it did not capitalize on its own innovations.

The Palo Alto Research Center (PARC) was a special research team funded by Xerox with the goal of coming up with new and innovative

technology. Ironically, other corporations (such as Apple) have used their ideas to make billions, yet Xerox itself never implemented most of those ideas as part of their own product offerings, demonstrating that sometimes innovation is a management issue. You may have the brightest innovators in your company, but if your managers can't implement those innovations, you have nothing.

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Although modelled on the concept of products, the same theory can be carried through to that of professional services – appropriate for our industry. Typically, the business model of consulting engineering firms has remained unchanged, with the introduction of small and strategic changes that accommodate local dynamics. The impact of disruption innovation has been seen over the years and some progressive consulting engineering firms have already begun to review their current business models, and to build those models to get ahead of the competition.

Let us explore some of the current examples of the technology-based internet society on professions:

In Education,

- a) More people signed up for Harvard Online Courses in it's first year of operation than those who attended the actual university in it's entire 377 years of existence.

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In Medicine,

- a) WebMD, a collection of medical websites and provides guidance on symptoms and treatments with 190 million unique users each month – that is more than all the patients who go to all the doctors practicing in the United States.

In Journalism,

- a) In 6 years, the Huffington Post has more unique users going to its site, than The New York Times that is 164 years old.

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In the **Built Environment:**

- a) Architecture Firm Gramazio and Kohler built a structure using a swarm of autonomous robots.

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- b) Dutch based, DUS Architects have built a house made entirely of printed parts and although in its infancy, demonstrating that there is a sustainable and environmentally friendly future for construction

From the examples cited, it is evident that there is a trend that reflects a transformation in the professions and how our services are delivered and received.

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Richard and Daniel Susskind, in their book *“The Future of the Professions: How Technology Will Transform the Work of Human Experts”* predict a decline in demand for the traditional professions and the conventional professional worker and foresee a variety of new and emerging roles.

They predict how the professions may be impacted by technology, with potentially two futures for the professions:

One – Reassuringly familiar, professions using technology to optimise and streamline what has always been done traditionally OR

Two- With technological advances, increasingly capable machines will not just optimise, but actively displace the work of professionals.

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To establish what the impact of technology disruption on professions will be, we need to understand why we have the professions. **Professions exist to solve problems.** As humans, we have limited understanding, so where no one person can know everything. So, the professions were historically the way we dealt with solving these daily challenges. In a **print-based industrial society**, professionals hold practical expertise that others do not possess. The professions operate under a grand bargain, where this arrangement allows us, to provide certain services to the exclusion of others. Effectively, the professions act as custodians responsible for certain body’s of knowledge in the professional’s area of expertise.

However, we are now in a **technology-based internet society** that shows that the traditional professions are antiquated, and often rely on old and tired techniques of producing work and sharing knowledge.

As we move from a **print-based industrial society** to a **technology-based internet society**, we see the changes that technology has brought to the professions and raise the question of what the future of professions holds.

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The First Industrial Revolution used water and steam power to mechanize production. The Second used electric power to create mass production. The Third used electronics and information technology to automate production. Now a Fourth Industrial Revolution is building on the Third, the digital revolution that has been occurring since the middle of the last century. It is characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres.

Engineering leaders need to think about the impact of the Fourth Industrial Revolution since technological advances in computing, data analytics and artificial intelligence, mean that computers can now simulate an expert's knowledge, set to disrupt the very notion of the professions.

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The Susskind's identified broad patterns that have the potential to unravel the traditional professions:

- a) A move from personalised services where there are inherent inefficiencies in a one to one delivery model.
- b) Decomposition of the professions – division of labour, where one could take complex professional work and break it down into simpler parts
- c) Routinization – looking at the parts of professional work that does not need to be hand crafted and can be subject to some form of automation.

Looking at these 4 aspects of technology, we can get a sense of where the world is going:

- a) Exponential growth: can be seen in increasing processing power, data storage, band width. Big data capable of doing correlations patterns, analysis, statistical predictions based on past events

- b) Increasingly capable systems – machines and systems are becoming increasingly capable, able to perform statistical analysis that rivals human processing power, systems with unlimited problem solving skills compared to humans - can answer questions about anything in the world, effective computing where computers can express and detect human emotion, facial recognition, authenticity of a smile and expressions as well as robotics such as self driving cars
- c) Increasingly pervasive – through smart phones and tablets, embedded in clothing and jewellery, The Internet of Things
- d) Increasingly connected – humans through social media – are connected to each other in ways that were previously unimaginable that collectively, moves us into a different world of online communities of professionals eg Archinect, social platforms that allows recipients of the services from professionals to connect with the professionals themselves and crowd sourcing where Clients can draw on a pool of advisors for solutions to problems eg Archbazaar

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So the way of the future is to find new ways to solve traditional problems with technology as an enabler. In organisations, we see evolving professional services:

Knowledge is not held only internally. The move from left to right is the **Commoditisation** of professional services.

Commoditisation and disruption of the engineering profession can be seen less by automation and more by the diversification of Management Consulting and Accounting firms moving into the engineering and infrastructure space, thereby employing engineering professionals as bolt-on service providers rather than core and key professionals to successfully plan and execute a project.

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With the effect of routinisation on the commoditisation of professional services; are computers getting smarter to the point that they may replace the brilliant mind of the professional? Artificial Intelligence is a way of making a computer system think intelligently in a similar manner to the way humans think.

First wave AI systems could implement simple logical rules for well-defined problems, but were incapable of learning, and had a hard time dealing with uncertainty.

In second wave AI systems, the engineers and programmers didn't teach precise and exact rules for the systems to follow, they developed statistical models for certain types of problems, and then 'trained' the models on various samples to make them more precise and efficient. Thus far, second wave systems have managed to outdo humans at face recognition, at speech transcription, and at identifying animals and objects in pictures and they're making great strides in translation, autonomous cars and aerial drones.

In the third wave, where we are heading, the AI systems themselves will construct models that will explain how the world works. They will discover by themselves the logical rules which shape their decision-making process.

Third wave systems will be able to rely on several different statistical models, to reach a more complete understanding of the world. Third wave systems would also be able to take information from several sources to reach a well-explained conclusion. These systems could, for example, replicate what lawyers in case law do with case studies and case history. They'll even be able to program themselves, and potentially develop abstract thinking and judgement.

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Will there be jobs left for human professionals and what does this mean for jobs? *"There are lots of ways of being smart that aren't smart like us". Patrick Winston*

In the medium term, one could mine the knowledge of an expert and create a system that non-experts can use, but in the long term:

The optimistic view: There is work today that only humans can do, new work will arise that only humans can do and humans and machines will work well together – optimum solution!

Pessimistic view: With machines becoming increasingly capable, there will be less and less work for humans to do.

What jobs can humans do that machines can't?

The pessimists are right to recognise that machines are becoming increasingly capable at existing tasks, but wrong to ignore the fact that there may be new tasks to be done in the future; and optimists are right to recognise that there will be new tasks to be done in the future but they are wrong to think that people will be better placed than machines to perform those new tasks.

Evidence suggests that machines will become increasingly capable and they will take on more and more of today's tasks but new tasks will emerge, but machines can take these on as well. The best and brightest professionals will last the longest and those experts who perform tasks that cannot or ought not to be performed by machines will stay relevant, but there won't be enough of these tasks to keep armies of professionals employed.

One could ask, but surely there must be tasks only humans can do? Can a machine replicate professional non-routine work that requires creativity, judgement, empathy?

Let's clear up some misconceptions about professional work:

Decomposition – When you decompose the tasks of professionals, not all or much of what professionals do is creative and requires judgement.

AI Fallacy: Mistake to think because a machine doesn't do non-routine tasks now, that it can't be built to do non-routine tasks in the Third Wave of AI;

Moral limits, Security & Intellectual Property: What tasks ought to be handled by humans fuelled by empathy, emotion and feelings eg. Switching of a life support system, the passing of a life sentence. A challenge that information technologies poses is privacy as the loss of control over our data intensifies. Similarly, the advancements in biotechnology and AI, that redefines what it means to be human by pushing back the current thresholds of life span, health, cognition, and capabilities, will compel us to redefine our moral and ethical boundaries.

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Since we are professionals operating in the business space, let's bring this back to the marketplace and what that means for consulting engineering professional services.

Overall, the shift from simple digitization to innovation, based on combinations of technologies is forcing companies to re-examine the way they do business. The bottom line, is the same: business leaders, management and senior executives need to understand the changing environment, to challenge assumptions and relentlessly and continuously innovate.

Future opportunities, can only be unlocked by analysing past failures. Let's look at some of the areas of failure that can negatively influence our business.

Failure #1: Poor Management Decisions

By relying on the skills of one's own internal experts, highly specialised expert silo's only allow for today's success, but also represent a major obstacles to further development. A decade ago, a group of experts estimated the half-life of an engineer's technical skills--*how long it would take for half of everything an engineer knew about his or her field to become obsolete*. Rapid change is not always comfortable. Think about it. In some specialties, the half-life of an engineer's technical skills is as short as 3 years, all the while working full-time to design products according to the best standards of the moment--which might change next month. In even the slower-paced fields, engineers must reinvent themselves at least once a decade.

A generation ago, an engineer could expect to carve out a niche in one well-defined specialist area and remain there for a lifetime. No longer possible! As technological change accelerates, and product lines rise and fall in ever-diminishing life cycles, engineers find themselves switching jobs more often, to the point that those starting out today, may hold half a dozen jobs over their careers, even if we manage to remain with the same company throughout. So besides staying abreast of developments in our own specialties, we must be prepared to switch to a new field when the old one peters out.

And, to complicate things further, these professional demands come at a time of upheaval in the employment landscape. Global competition and procurement has resulted in significant right-sizing and retrenchments in firms, destroying much of the job security that engineers used to take for granted. This pushes companies to contract out more and more of their design work leaving little room for the innovation we desire.

Failure #2: Organisational Size

Growing organisations replace creativity by processes. For the short and medium term these companies remain successful, have little to think about, make fewer mistakes and are efficient. The fact that staff members who think out of the box are leaving won't bother anyone at first. At some point in time, efficiency will have overtaken creativity and flexibility and difficulties appear at the slightest of market changes. So we often don't react correctly, and stick to the old, tried and tested but no longer relevant rules, by responding to today's questions by giving yesterday's answers. We have seen the both sides of the coin in merged and newly acquired consulting engineering firms.

Failure #3: Integration and leadership

Organisationally integrating a newly acquired or developed disruptor into an existing firm can often lead to new group being fully exposed to corporate policies, long approval rounds and notorious naysayers. That way, innovative and promising projects are watered down by the technical disciplines before they can even be presented to the Board.

Some of these are because of systematic causes rooted in the management structure:

- *Lack of courage in the senior management:*

Top managers show a lot of respect for their traditional business segments and aim at implementing a balanced defence strategy than an aggressive strategic plan. It is very unusual to find a Board member voluntarily leave his or her position to manage an innovative start-up company or department.

- *Obsolete leadership model*

Hierarchical organisational structures are only suitable when the situation is not too complex and transformation is not too fast. The fact that corporate careers are no longer as attractive as they used to be and that ambitious and talented professionals are no longer interested in selling new ideas to slowly reacting groups within a company, means that technological change has made the professional mobile, by taking these things into their own hands.

Therefore, there is an urgent need to be innovative to deliver value in services and dynamic teams to optimise digital and global strategies whilst still competing for a market share with other Built Environment and Management Consulting Professionals to run profitable businesses and attracting and retaining the best human capital.

Failure #4: Relying on the experience of established managers

Typically, companies pay their managers more money because their experience with regard to dealing with success and failure enables them to do the right thing. They are assigned to their positions to help save valuable time which less experienced people would need to solve the problems with the same level of quality. However, experience and qualifications usually stand in the way of the managers as soon as disruption comes into play: power relationships are reversed, lack of knowledge overturns the advantage of longstanding experience.

“One of the biggest flaws in the common conception of the future is that the future is something that happens to us, not something we create.”

Michael Anissimov

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In summary, with an evident transformation of the professions with the advent of technological disruption, how should firms adapt to the digital age?

1. **Transform our culture and people model:** Whilst core competencies of the professional remain the same, the workforce of the future will evolve. It will be more flexible, more diverse and attract new types of talent, backgrounds and competencies. Rethinking how our organisation should be structured, and the culture our people should embody – is going to be key to enabling the transformation.
2. **Embrace new technologies:** Developments in technology such as big data and AI are providing perceptive tools for professions. Technology allows us to ask better questions about our Clients needs and to help them make better, quicker and more informed decisions and ask “How can I best apply these technologies to my work? Engineering examples, introduction BIMS, Quantum Alignment Planning Software, Bentley, AutoCAD 3D, has changed the way we work. Again, Peter Thiel cleverly put’s it that “In a world of scarce resources, globalization without new technology is unsustainable.”
3. **Prepare for more innovation:** While the digital age is upon us, there is far more innovation ahead of the profession.

4. **Adapt or get left behind:** Disruptive technology will make our work more dynamic, will occur in near real time and can produce more tangible insights.

Parting shot: **The message is clear, disrupt or be disrupted – which one are you!**

Sources:

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