National Platform for the Built Environment

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Internet of Things Workshop Report
Construction Technology: road mapping the next 5-10 years
Wednesday 20th April 2016

Keynote Presentations by leading researchers and practitioners

Professor Jeremy Watson, Vice Dean at UCL, Chief Scientist and Engineer at BRE, President Designate of the IET – Challenges in the Digital Built Environment

Evidence demonstrates that the construction industry contributes significantly to the UK economy. Jeremy explained the Government strategy 'Construction 2025' which looks to make improvements to the way industry works. One area identified within this strategy which could help improve the way industry operates is BIM. The Government recently introduced the mandate for BIM Level 2 in April 2016, and are now looking towards realising the potential which BIM 3 can offer.

BIM 3 goes one step further than level 2 by enabling live data to interact with the static objects. For example, a model could now be receiving data from a number of sensors, including HVAC systems; energy meters; lighting; noise sensors, and temperature sensors. By taking this extra step it leads further considerations such as the 'Internet of Things', and how we ensure that the data being collected remains private.

Cyber security will become ever more important, as we start to allow digital systems to interact with the physical environment. There is the potential for these systems to be manipulated in order gain an advantage. For example, by gaining access to energy consumption data it is easy to understand occupancy patterns of a building, allowing someone to understand when best to commit theft.

Jeremy discussed his work with the research hub PETRAS. This was set-up to drive forward UK research in the Internet of Things (IoT). The PETRAS consortium of nine leading UK universities will work together over the next three years to explore critical issues in privacy, ethics, trust, reliability, acceptability, and security. For more information please see:

https://www.epsrc.ac.uk/newsevents/news/iotresearchhub/

Professor Tim Broyd, UCL, President Designate of the ICE – Rising to the 2025 Challenge

Tim started by describing the issues which are driving change within the built environment, including; growing population; ageing demography; increased urbanisation; climate change, as well as the ever increasing ICT capabilities. Tim explained the current state of the construction industry, with figures suggesting that 98% of projects incur additional costs relating to overruns or delays.

Construction appears to be struggling to improve its productivity, while other industries are continuing to progress. One thing that is apparent, is the fact that the amount of information being exchanged with the construction industry is much smaller than that seen in others industries.

When Tier 1 contractors were asked which areas they are targeting to achieve improvements, Tim illustrated that many had not considered topics such as, behavioural change, big data or IoT. Tim pointed out that currently there is fear within industry in relation to BIM 3, due to the potential for changes in the way in which projects are contracted.

UCL are taking a proactive step to try and provide more information in this area, by creating their Institute for Digital Innovation in the Built Environment (iDIBE). iDIBE is a hub which brings together digital innovation in the built environment expertise across academia, industry and policy. There is also progress on developing a Masters programme on Strategic data driven asset and facility management.

Sasha Njagulj, Bouygues UK – Constructing Smart and Secure Buildings

One of the major issues at the moment within construction is an inability to close the gap between the modelled design, and the operational performance. The Government have put in place several measures to try and improve this, such as the BIM level 2 mandate, as well as introducing soft landings. However, the construction industry in notoriously slow at engaging with innovation, and subsequently change is often slow. Industry was given five years to get up to speed with BIM level 2 for the Government mandate, although currently almost half of organisations still haven't been involved at all with this level.

The complexity and size of the supply chains seen within the industry is currently hampering the uptake of innovation. What is more concerning is that in reality industry needs to go further than BIM level 2, and must start looking at collating big data which can help to create further potential for efficiencies. This will be the next hurdle for the supply chains.

In order to get to this point there needs to be significant work undertaken on training. As well as this, there needs to be interest and drive provided by the clients. Changes will need to be made to the way that procurement is undertaken within construction if we are to reach these levels, as currently the supply chain is not prepared for this.

Martin Gettings, Canary Wharf Group – Building and Accelerating Technology for Future Cities

Martin discussed the creation of Canary Wharf's 'Level39', Europe's largest technology accelerator space for finance, cyber-security, retail and smart-city technology companies. This creates a physical space for start-ups to network, while also providing them with guidance from mentors.

On the back of this innovative space, Canary Wharf created the Cognicity Challenge. The Challenge looked for entrants to develop technology which could help provide smart cities. Shortlisted entrants are provided with expert guidance from Cognicity Challenge partners and sponsors. The winners receive a £50,000 cash prize, as well as the opportunity to pilot their solutions in the ongoing development of Canary Wharf.

Martin explained that no longer can these approaches be exceptions, this needs to be business-as-usual. However, this will require a significant behaviour change, which is

something that people often struggle with. Although the technology is often available to make the improvements industry requires, behaviourally the occupants are not ready. In order to overcome this industry needs to link these changes to topics which the occupants care about, such as health and wellbeing, and indoor environments, rather than energy or water consumption.

Dr Ioannis Papakonstantinou, UCL – "Smart" Windows, Nanotechnology and Photonics

Windows are often considered to be one of the weakest links in a building in regards to energy efficiency. Considering that 40% of energy usage is undertaken indoors, while 70% of electricity generated is consumed indoors, it demonstrates that this is an area which could be targeted.

Ioannis explained about the research UCL are undertaking in this space. It is possible to design a window which can regulate the amount of infra-red which enters a building. This can allow a building to be heated on colder days, while preventing the infra-red entering on days which could lead to overheating. Technology now allows this to be regulated by the temperature of the window. For example, if a certain temperature is reached a window can prevent any further infra-red entering through.

By reducing heating and cooling demands, there is the potential for these applications to create efficiencies greater than solar cells. As well as this they can also be designed to have self-cleaning properties. Finally, there is even the possibility for this technology to be installed retrospectively, by covering the previously installed windows with a specially designed foil. However, the efficiencies of these retrofitted systems do not match those for purpose built windows.

Dr Emil Lupu, Imperial College London – On Sensors, threats, responses and future challenges: some lessons learnt from computer science research

Bringing the digital world to work closely with the physical world will bring around a range of different opportunities. However, by doing this we are now exposing our physical world to cyber threats, meaning we need to consider a completely different type of security for the built environment.

Computer science is now very familiar on how rule based systems can be used to create feedback. However, one drawback is that this often requires someone to type in the rule in the first place. Alternatively, there is the potential for artificial intelligence to be used to create and adapt rules based on evidence. It can make these decisions based on the data collected by "smart" technologies. For example, a system could use data collected on occupancy patterns to create a rule within the building management system on when the heating comes on/off.

Emil has been undertaking research into how systems can detect whether false data is being collated. There will be instances where saboteurs may want a system to believe a certain reading is being provided, in order to either elicit a problem, or alternatively mask an existing problem. Emil has set out to develop new techniques to identify malicious injections of data,

whether they are single events, or more long-term. The results have been positive, but they need further validation. The main difficulty up-to-date in the study has been systematically testing for sophisticated attacks.

Technology road mapping for the construction sector

Background

The aim of this workshop was to better understand what people felt were the current drivers and trends within the construction industry. Next, how would these trends look in the next decade? We must understand the needs and gaps (both knowledge and capability) which is currently preventing industry from reaching this potential future in the next 10 years. Finally, what research needs to be undertaken to successfully close these identified gaps, who would undertake the research, and what would the research project entail?

Stage 1 - Drivers and Trends

This was a plenary workshop where all of the attendees were free to raise anything which they felt were currently a driver or a trend within the industry. In reality many of the answers provided by the group were related to issues currently preventing the UK adopting a "smarter" construction industry. These answers were then organised into similar topics. These overriding topics would then be used to guide the later stages of the workshop. The following topic areas were created:

Data & IoT	Behaviour change	Business models

Stage 2 – Needs and Gaps

The attendees were then split into three groups, and each were given one of the three topics identified above (Data & IoT; Behaviour change; Business models). Then the groups were asked how their topic area could look in the next decade, and consider the needs and gaps (both knowledge and capability) which need to be filled in order to reach this. Below are the answers which each group provided for their respective topics.

Group 1: Data & IoT
In order to advance within this area there is a need to address the following: - Provide large scale integration of all assets and visualisation of those assets - Create interoperability across all platforms - Provide a clear vision for what success will look like in 2026 - We need data informed strategies, and the creation of new roles in organisations (e.g. Chief Innovation Officer) - Creating real business value from new business models – these business models need to be related to data - There is a risk that we will be capturing dynamic real time data on assets/process that are currently intangible - Tackle the security issues associated with current devices - There needs to be an openness towards culture change - Consider issues with ownership consent of data, as well as the associated liabilities

- Create an appetite to invest in new technology/business models

Group 1: Other talking points

One thing that could hinder the uptake of data utilisation is the lack of appetite to invest, there needs to be a culture change.
It is felt that the PETRAS programme fits well with this agenda.
Government is becoming aware of the problem surrounding data hacking, but who owns it? Who is looking after the information?
We need to talk further about consent as well – everyone involved has to consent.
One issue for Government is that definitions of data are industry specific, however they need to be Government specific too. In the US they have rights to IR, currently in the UK we do not.

Group 2: Behaviour change

This group wanted the industry to be "Collaborative by Design", which would involve a "Provision of worthwhile facilities by an integrated team, who work with familiar technologies, understand the value of data, and collaborate within a trusting commercial environment". The current needs and gaps are:

- We must define the value of collaboration
- Traditional commercial models
- Single goal for the project
- Erode silos within organisation
- Clients must understand this type of approach – and buy into it
- Improve collaboration between organisations
- Public policy shifts, regulation currently stifles progress
- A need for an appetite for risk
- Currently BIM is very complex and inaccessible – this must change
- There is a need for improved understanding and skills
- Consumers placed ahead of commerce

Group 2: Other talking points

Currently it is difficult to get industry to understand the potential which collaboration can offer? The only way they will develop an interest is through monetary benefits. We need to demonstrate and define the value of collaboration.
Currently, different parts of companies will often compete for the same contract, which demonstrates the issues the industry has. Need to collaborate – easier to deal with clients than 'parent'.
There is a problem with risk appetite – BIM is still considered to be very complex. How can we make this approachable for the 'man/woman with a van'? How can he/she log on and utilise this technology (iPads/tablets). There is a need for an improved understanding and skills. Future generations will be ever more online – we need a behavioural shift in order to get value from our employees.

It should be noted that Behaviour Change refers particularly to behaviour at the industry and corporate level rather than the behaviour of building occupants.

Group 3: Business models

Currently the construction industry is felt to be:

- Risk averse

- Undertaking silo thinking and working
- Short term thinking, by developers – not helped by political inconsistencies
- Slow to adopt new ideas
- Constrained by a bad reputation
- Complex and fragmented supply chain
- A large proportion of the industry is made up of small organisations – this currently makes it difficult for skills development
- Lack of data / information flows / sharing
- Hierarchical

In 10 years, the group wanted an industry which could "Capitalise on opportunities that the Built Environment can bring – to address the 2025 Strategy". This would include an industry which is:

- Driven by market forces
- A greater network of communication between organisations
- Increased collaboration
- Using big data to realise opportunities
- Using big data and analysis to drive value
- IP should be on the balance sheet of organisations
- Faster and better decision making is need – this can be driven by data

Group 3: Other talking points

New graduates are getting up to speed much faster. Graduates are coming out with amazing ideas and will easily get jobs, but may be disappointed/disillusioned when they realise the job entails 'old/boring' ways of working. They will learn the job and leave.
It is also important getting the older generation up to speed to ensure that the industry can move forward while also retaining all of their knowledge and expertise.
We need to further undertake training and make things much more user friendly. This line of work (data) cannot be specialist - it needs to be easy.
Incentives are needed – regulatory can be used as the stick, however we need money for the carrot!
Customers of the future will say what they want, not what is forced on them. Currently the problem is that they don't know what to ask for yet, as they haven't seen it!

Stage 3 – Required Research

Building on the work produced in Stage 2, each group was now asked what research needs to be undertaken to successfully close these identified gaps. Consider who would undertake the research, and how would this be achieved?

Group 1: Data & IoT			
Theme	What?	Who?	How?
Culture Change	Large Tier 1 companies become data-led with construction sector	Executive buy-in	Highlight cost savings from new technology being implemented (including from potentially reducing risks)

Pilot projects/ testbeds	Test new technology / standards for interoperability / security & data issues / policy	Executive buy-in from those in charge of leading flagship industry projects, e.g. Crossrail, making innovation essential part of contract. PETRAS – influence Government, insurance companies, industry.	Timely projects with real/easy to understand data and clearly targeted results. Share results widely of innovative projects which positively influence the bottom line.
Group 2: Behaviour change			
Theme	What?	Who?	How?
Data (BIM) is very complex and inaccessible	HCI – Interpretation / Interface	UCL / IBM / Deepmind / Leeds University	Company / UCL staff / Exchange studentships
Erode silos within organisation Define value of collaboration Improve client understanding Improve collaboration between organisations	Social sciences Behaviour change Change management	UCL / ICW	Industry Club
Public policy shifts – regulation stifles progress	Government policy needs to be influenced / changed	UCL Department of Science, Technology, Engineering and Public Policy (STEaPP)	Tax incentives for early adopters
Group 3: Business models			
Theme	What?	Who?	How?
Network	Decouple from old ideals. Practice real collaboration by: Sharing workplaces	Contractors groups Build UK Considerate(?) constructors Construction Leadership Council UKGBC	Published case studies that evidence the value created by collaboration.

	De-badge, i.e. no company names, no job roles, true JV, not just a few companies, but the whole sector!	CIC	
Realise opportunities Collaborative / cross silo	Potential to exploit the major regeneration programmes (Old Oak Common / Canary Wharf new phase etc.) as testbeds for new business models	GLA could co-ordinate the developers / contractors University to observe / measure / report	Published case studies that evidence the value created by collaboration.
I.P. on the balance sheet	Guidance on how to value I.P. in a business and show it on the balance sheet	KPMG / PWC / Deloitte	Pay them. Ask for a freebie – BD? - opportunity to be part of the future – business development Second into a University
Using big data and analysis to drive value Value creation properly understood Faster and better decisions	Published case studies 'Toolkit' for new users Training and skills development	Framework teams Best big data exploiters Universities / research organisations / industry people to get trained	Research project

Summary – National Platform Recommendations of Research Gaps

- Consideration needs to be given to the knowledge, capability and skills needed to develop business cases for the confluence of digital technologies and data with the construction sector. Specific focus on understanding how data can open new business opportunities and make a tangible impact on industry productivity and whole life performance of built assets.
- An economic and socio-technical challenge is how the supply chain can both collectively and individually extract value from pervasive / digital technology?

- There is a need, driven by perceived risk and cost, for a mechanism to encourage industry to create test-beds and use cases for the widespread of data and digital technologies.
- A socio-technical challenge of translating digital terminology to match the language of built environment supply-chain from designers, manufacturers, engineers, contractors, developers, through to facilities and asset management.

Summary: UCL Perspective

The meeting showed the very clear deficiencies relating to adoption of new technologies by the construction industry, for example those relating to the deployment of BIM systems, and this is particularly concerning when considering the imminent deployment of IoT technologies in the built environment.

Widespread deployment of IoT in the built environment has the potential to deliver substantial transformational change, but needs to be carried out in the safest manner possible.

It is evident that there needs to be a culture change within the construction industry to make it easier to adopt technologies that have the ability to deliver step changes in performance.

Additionally, considerable focus needs to be placed on methods to be used for data analysis so that the complex data rich environment that will be generated by the deployment of IoT technologies can be best utilised. This topic has the potential to be the basis for many research programmes between industry and academia.