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Digital buildings: facing the challenges

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Keynote address

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We will face many challenges in the next twenty years and beyond: *physical challenges* such as mitigating climate change, adjusting for its effects and for shortages of resources and *socio-economic challenges* such as population growth, political instability and economic uncertainty. Against this global context, considerable expectation will be placed on the construction industry and its clients to deliver infrastructure that is both appropriate and (in the broadest sense) resilient. Additionally, the challenges are characterized by uncertainty, are increasingly complex and probably conflicting. They also lie within fiscal and regulatory contexts that are likely to be subject to significant change.

The particular challenges facing the building construction sector up to 2030 include:

Understanding needs: To address issues like flexibility and adaptability the design and investment decisions relating to a particular building need to be better informed about the short, medium and more particularly the long term requirements of the client and of the locality. The latter is a pivotal challenge, but one which extends well beyond the orbit of the industry and it's immediate clients.

Energy consumption: Improving the performance of the building stock as-a-whole will require a combination of highly energy efficient new-build, and the (more challenging) upgrading of existing buildings, together with the localised harnessing of renewable energy sources.

Sustainable: Needs to improve over the whole life-cycle of a building with an emphasis on conserving scarce resources, reducing embodied energy, re-use and recycling.

Resilient: To minimise repairs, disruption and potential loss of life, new-build and existing buildings need to be more resilient against growing threats (natural and man-made).

Costs: Need to be driven down, but with the emphasis shifting from capital cost to whole life-cycle costs and the avoidance of errors and rework.

Value: Striking the right balance between costs, functionality and performance, quality and the visual perception of a building is critical to delivering best value.

Life-cycle processes: Need to achieve greater integration of the design, manufacture and construction processes and extend such integration through the life-cycle to span facilities management, mid-life upgrades and ultimate disposal.

Multi-aspect design: The progressive adoption of a more holistic view of the design process will create an increasingly multidimensional and probabilistic design space. Thus it will be a challenge to set appropriate design parameters and increasingly difficulty to find and recognise good solutions.

Within these challenges some common threads can be identified: the increasing requirement to consider the building within its wider context, the greater design effort necessary to justify the commitment of physical resources, the wider implications for the contractual relationship between the stakeholders and the probability that building refurbishment and redeployment will increase in importance.

Given today's context, it is inevitable that formal product models (such as the model which underpins the IFC data exchange standard) and agreed process models will play a significant role in addressing these challenges. BIM software (such as Revit Architecture), which is based on the concept of a product model, is now displacing traditional CAD. While this is partly due to the evident advantage of easy 3D coordination, the real significance lies with the underlying database that effectively defines the building. The fact that it is now feasible to create a coherent digital prototype of a building has profound implications that parallel the earlier introduction of CAD/CAM into manufacturing.

BIM software is already an effective participant in interoperability with other software using either open data exchange standards like the IFC or proprietary data standards. By allowing evaluations of the current design against specialist requirements to be conducted more easily, the close coupling of external analysis and simulation programs to BIM software is rapidly become an invaluable and inherently extendable design tool. As this implies, the BIM model will soon lie at the centre of the design process and thus will provide the first real platform on which the construction industry can implement multi-aspect design.

Similarly, BIM is already reaching down the life-cycle past fabricators and contractors (BIM software with 4D and 5D capabilities for example) towards facilities management. This highlights the long-term importance of the digital information that is contained within the model rather than the particular BIM software that was used to populate that model. Already the drivers for continuously maintaining and updating a *digital building* in parallel with the physical building are strong. It seems inevitable that by 2030 this will be the norm.

It can be inferred that over the next twenty years the building construction sector will pose significant challenges to its IT suppliers, it is also likely to be an important market. Although current BIM software will then appear primitive and the term BIM may have been replaced, it is likely that the general concept will remain. The IT challenges are likely to include:

Growing scope: As the design process becomes more comprehensive new and extended types of specialist application software will be required.

Integration: This trend will increase the number of software modules to be integrated as will the need for more effective integration both across supply chains and down the building life-cycle. The situation is complicated by commercial pressures, national differences and the relatively poor funding of open standards. Governmental regulations may intervene on the choice of integration standards.

Multi-user: Current BIM software is discipline specific with only limited multi-user support. Providing the design team with concurrent access to a unified BIM model will raise many challenges.

Multi-aspect design: Current single aspect assessment tools will increasingly need to be replaced by automated tools that can guide designers to good solutions across multiple criteria. This implies increased need for optimisation, particularly where probabilistic data is involved. This will involve taking the construction industry into unfamiliar territory.

Knowledge-based: Thus far knowledge-based approaches have not had a significant impact on construction, but the existence of standard objects for describing the elements of a building will change the balance. For example, case-based reasoning could be introduced to leverage previous designs. Knowledge-based approaches could also be deployed in the management of the design process.

Clouds: The major CAD vendors are already trialling cloud computing, a technology which could prove to be important in the future delivery of IT to dispersed design and construction teams. Creating a new digital building to correspond to an existing building will be a major challenge, clouds of scanned data points probably prove to be one of the data acquisition tools that will help.