Creating a Digital Twin: BIM as an everyday activity

My friend used to say: 'You architects are forever making models…' He was in fact referring to cardboard and balsa wood models, but the statement still holds true, possibly even more so. Things have moved on and we now make many models to test, explore and coordinate our designs. Many of our current buildings would not be possible without a range of parametric computational tools and precision digital manufacturing. The 'buzz word' of the year is the 'Digital Twin' but everyone is a little unsure about what that means for the construction industry. However, as Ana Matic explains, the 'Industry 4.0' is here to stay and the question for us, as professionals, is how to lead and harness its ever-increasing powers but remain focused, creative and profitable.

This year's UK Construction Week featured a rapid bricklaying robot alongside 'flying' onsite digital cutting factories for housing developments. Meanwhile, back at the RIBA, their annual Smart Practice Conference featured new ways of collaboration and each presentation showcased some aspect of utilising connections between digital and physical: from creation of hyper-efficient materials to large client-led developments utilising Design for Manufacture and Assembly. (DfMA)

Most of our creative activity and production has become digital in some shape or form. We are starting to use the term BIM as a generic noun to describe a multitude of tools and applications which combined with the need to have a universal 'language' allow us to work together. So, BIM *is* an everyday thing. Like WhatsApp and internet banking. Pupils in schools are busy 3D scanning their classrooms and parents are controlling central heating from their phones. Tracking the progress of your Uber driver is already a norm and 'self-regulating' environmental controls are specified and installed in most new buildings as a baseline standard.

What does all this mean for us as architects? The expectations are changing towards being able to handover intelligent models to end users which will be able to live, learn and inform the use and maintenance of the built asset. Although we are generally not responsible for the coordination of asset data delivery – it is our role as the Lead Consultant which enables us to guide the process. The more knowledgeable we are the easier it will be to be precise about our role in developing Digital Twin deliverables and advising our clients.

> **"A UK industry that leads the world in research and innovation, transformed by digital design, advanced materials and new technologies, fully embracing the transition to a digital economy and the rise of smart construction."**
>
> UK Construction Strategy 2015
> Vision Statement

The pressure we are already starting to feel in practice is the push coming from the opposite direction – the construction and 'In use' stage of a building's life. There is a need to be able to respond to, and facilitate collaboration with digital tools used by the main contractors to plan and programme construction but also to improve accuracy of construction projects. Interactive 3D scanning of site progress feeding back into a federated BIM model is becoming cheap and attainable. But this also means that our ability to receive and act upon this new flood of information will become a standard requirement for our delivery sectors.

The vision statement of the Government's Construction Strategy for 2025 builds upon the legacy of developments in the last couple of decades. Starting with the Egan Report, 'Rethinking Construction' in 1998 and followed by 'Accelerating Change' in 2002 and the work done by the Strategic Forum for Construction, we have underlined the future importance of information technologies and their integration into the UK construction industry. Concepts that were developed in the years to follow are captured in the Construction Strategy 2025 Vision Statement:

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The strategy sets out ambitious targets for the reduction of capital and whole life costs of 33%, and an almost fantastical target of 50% reduction of construction project delivery times (both newbuild and refurbishment). These are bold targets, but for us as practitioners, the interesting aspects are how the changes in the industry are going to change the way we win work and stay focused and relevant.

THE USE OF DIGITAL TWINS

Throughout the manufacturing and haulage industries, which depend upon the use of complex digital logistics networks, Digital Twin(s) are commonly employed to enable a whole range of iterative activities between the physical and the digital entity. To use an example recently

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Augmented Reality for FM and Operations | Copyright HoLoLens Technology

featured on the news: car manufacturing throughout the EU works on the principle of 'Just in Time' delivery, taken to an absolute extreme. This means that the storage of parts is almost non-existent at the point of assembly, but completely dependent on thousands of trucks delivering parts from different countries with minimal time tolerances. A lot of the logistic planning (both on the factory floor and throughout the transport fleets) depends on self-updating systems which incorporate AI supported functionalities.

To apply to large public institutions or clients with the need to run complex estates (universities, airports, hospitals) – the need for some aspects of Digital Twin simulation management will soon become a common expectation. The Internet of Things [IoT] will make its way into our lives via large public systems and infrastructure, but it's not long before we will be required to indicate how we can lead the team to provide Digital Twin-ready BIM models and lead our client to create a suitable brief to enable this.

As iterative management becomes adopted as a norm for new developments, we will find that the 'Digital Twins' we helped create are able to continue their independent lives as 'Lightweight Digital Replicas' of the physical system or structure. This lightweight model will be enabled to grow and mature but also influence the life of its physical sibling. As with all systems, the question of ongoing maintenance will be the biggest hurdle to overcome, but a large number of UK institutions are currently undergoing 'digitisation' of their current stock and specifying delivery of functional CAFM models as a standard. Our current understanding of this process tends to be patchy and limited. Let us try to understand some of the key activities we are expecting Digital Twins to perform:

Remote Monitoring: For example energy or heat monitoring or fault recording and reporting is already used for large interconnected systems. Development will be exponential due to the nature of the systems in question and requirements for health and safety.

Simulation: The ability to simulate future behaviours of systems as well as spaces and entire masterplans will dramatically change the way we design. Normally seen as a tool developed for large manufacturing processes, the →

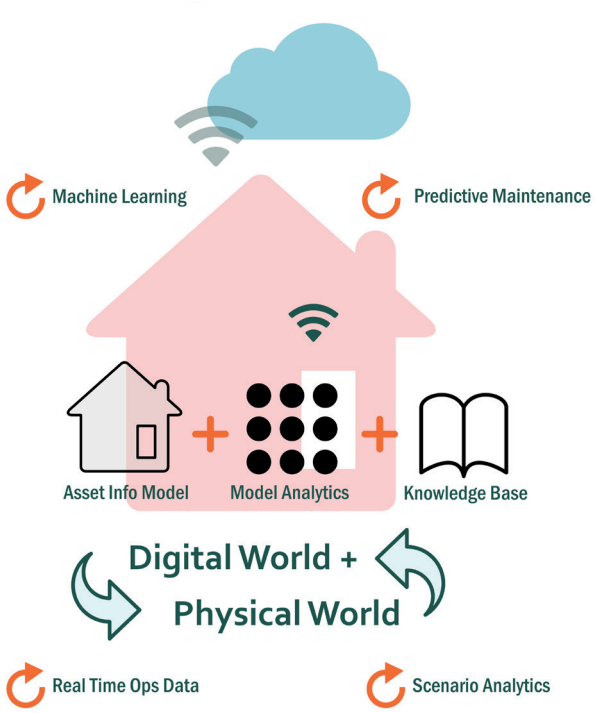
DEFINITIONS

Digital Twin Concept
Professor Michael Grieves describes the 'Digital twin' as a virtual, digital equivalent to a physical entity. In order to have a digital twin three main prerequisites should be in place: Physical products in Real Space; Virtual products in Virtual Space; The connections of data and information that ties the virtual and real products together.

IoT – The Internet of Things
The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

Industry 4.0
The term Industry 4.0 encompasses a promise of a new industrial revolution—one that marries advanced construction and facilities management techniques with the Internet of Things to create asset management systems that are not only interconnected, but able to communicate, analyse, and use information to drive further intelligent and informed action back in the physical world.

BELOW
Digital Twin diagram: Physical and Digital World connected and interacting



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AR-Mixed Reality for Construction Management
Image courtesy of Microdesk

BELOW
Signmund Freud's House: 360VR immersive photography
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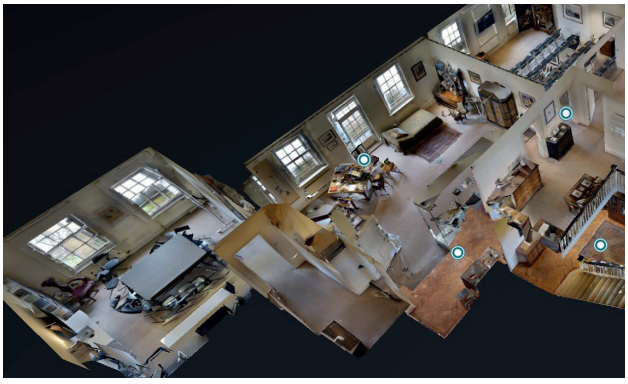


development of sophisticated computational power will mean that we will be able to test our designs within simulated environments but will also allow facilities to prepare responses to external changes. Predictive analytics of errors and problems which could cause downtime could be used.

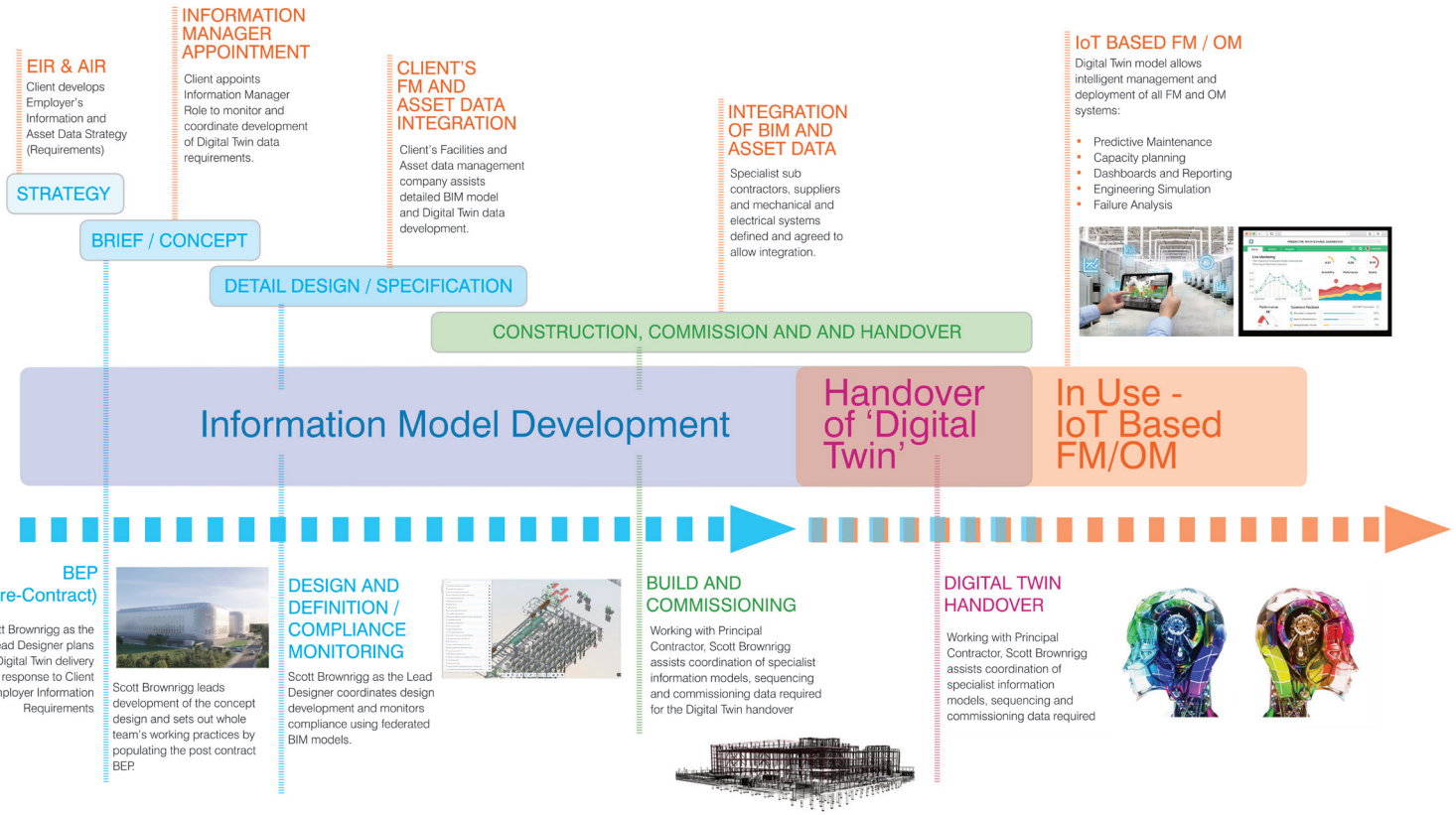
Optimisation: The world with ever decreasing natural resources is going to look for ways to use digital tools to achieve ever greater ways to optimise. We are starting to look at concepts like 'Hyper-optimisation' and 'Cyber-physical' systems which allow virtual prototyping. Explained simply, we will stop building things to fit the 'standard' materials we can source in order to start forming the materials which are able to perform in many ways better than their standard counterparts.

Global Twin Control: Although this sounds quite frightening as though it's arrived straight from a Terry Gilliam movie, global twin control is simply a concept of our ability to batch-plan and batch-manage thanks to a number of Digital Twin systems communicating with each other. Most of these activities are already present in large manufacturing facilities and MEP heavy installations, some of which are relevant to Scott Brownrigg's design portfolio: data centres, aviation and rail infrastructure. However, they will soon be expected in universities and schools and will have a huge impact on healthcare design and planning.

Digital Twin and advances in BIM collaboration:
In the recent years, considerable effort has been made to enable Building Information Management technologies to work collaboratively in an organised way, in order to produce understandable, legible data. BIM is truly becoming an everyday thing, not only because of its original purpose – to speed up design and construction of built assets – but also because of its value and ability to track, maintain and learn about its digital counterpart. The future of BIM creation is that of a 'connected' era, enabling the Digital Twin to live, grow and update in 'near real time' as the state of the physical object changes. As with everything, this will initially be best utilised in large infrastructure, transport and public projects, but the trend and the need to be BIM3 ready will quickly filter down to smaller developments.

In February this year, the UK adopted the new ISO 19650 Standards. The first issue of the UK Annex confirms the use of internationally established standards and introduces some (but luckily not big) changes in the way we set up teams and collaborate on projects and the way we organise information delivered throughout the life of the project and in anticipation of the (much longer) life of the actual building. Internationally adopted standards for naming and measuring things will allow us to hand-over usable data. Today's BIM is developing towards the concept of the Industry 4.0 and the Industrial Internet of Things. BIM is not merely about CAD models, it is about management of consistent, traceable data which follows common structures, common definitions and common logic.

New project management systems are increasingly based on 'live sharing' or 'live hosting' of cloud models and project information management, which uses Meta data inscription. Some of Scott Brownrigg recent projects which are using Next Generation BIM 360 collaboration already utilise 'scheduled publishing' of both 3D model and information data but also selected published sets of 2D drawings – for review and 'consumption' by the client and the project team. We are hoping to be able to influence the work of statutory bodies



ABOVE
Digital Twin Development and Delivery Process

by introducing new ways of model and project review via live cloud models. Scott Brownrigg's Edinburgh team are working with West Lothian Council's Building Control department to investigate the potential for cloud-shared 3D and 2D content to be submitted directly to a portal shared with the Local Authority. Similarly, for our High Barnet project in our Chiswick studio, the planning submission requirement is to deliver a native Revit model with a selected number of 2D outputs. In the very near future, this will be a common requirement – hopefully leading to further standardisation of our collaborative environments.

FUTURE OF ARCHITECTURAL PRACTICE

Some of the key trends of 'Smart Construction' development which will affect the way we practice will be apparent in both the micro and the macro scale of our daily activities:

- Ability to lead client teams in developing Digital Twin strategies .
- The rise of machine learning and AI in construction practice, particularly in monitoring Health and Safety and pre-analysing high risk activities.
- Ability to partake in large offsite frameworks – with gradually developing capacity to develop 'digital twin' asset legacy.
- Using digital simulation during design and construction with better integrated digital tools.
- Successful collaboration directly with manufacturers / suppliers – shortening programme time by synching development of early stages and detailed stages of the design.
- Working with Estate Management teams procuring university, healthcare and infrastructure projects.

Full 'Digital Twin' delivery for construction projects will be dependent on a number of factors. Scale and type of the project will be crucial but also type of procurement and project context. Traditionally, commercial and private sectors have led the way in terms of visualisation, AR and client-led digital capabilities. Meanwhile, the ability to manage and deliver organised 'as-built' models packaged with commissioning data and CAFM information will be essential for all public sector, infrastructure and large institutional project delivery. As Lead Designers, our strength will come from understanding the process of that delivery and being able to guide the process confidently.

Our future as consultants remain vested in our ability to observe, analyse and lead. Getting on board with the Digital Twin technologies early and proactively will allow us to widen our offer to clients and utilise our skills towards a leaner circular economy of the future ●