Can AR and VR allow us to build beautiful

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Imagine walking through the rooms of your new home before they have been built. Experiencing the sense of shape, space and light virtually would enable you to influence the design, function and construction before the build starts; move the position of a door, make a window wider to capture a view, lower a sink to secure easy access for a wheelchair user.

Being able to inform the design and construction of your own home is a luxury more often than not reserved for those sufficiently wealthy to commission an architect. But as the pace of technological development quickens and industry increasingly adopts digital construction, the opportunity to participate in the process of creating our homes could become the rule rather than the exception.

Data-driven construction

Technology is already shaping construction. We are living in a dataabundant age hailed as the fourth industrial revolution. Digital is driving change across all industries and the construction sector has much to gain. The Government's overarching Industrial Strategy (November 2017) and accompanying Construction Sector Deal (July 2018) acknowledge the significant role construction plays in underpinning our economy and society and its potential to deliver wide-reaching social benefits. Setting out the collaborative framework for a partnership between government and industry to transform the sector's productivity through innovative technologies and a skilled workforce, the sector deal report is visionary in tone, championing the shift to whole-life asset performance and the intent to secure the UK as a leader in the artificial intelligence and data revolution. This combined political will and appetite for change offers a significant opportunity.

Digital construction enables us to transform the way we plan, build, maintain and use our social and economic infrastructure, facilitating a new approach to construction that recognises whole-life value. The next decade will see digital technology combine with the internet of things, advanced data analytics, data-driven manufacturing and the digital economy to enable us to plan our built environment more effectively, build it at lower cost and operate and maintain it more efficiently.

Virtual Reality (VR), the visually and audio-visually immersive technology that transports the user into an interactive 3D environment, and Augmented Reality (AR) that blends virtual elements into the real world, are predicted to reach a plateau of maturity in two to five years and five to 10 years respectively[1]. These technologies are forecast to merge into mixed reality devices that allow the user to overlay data-driven virtual elements with their own view of reality. The evolution of VR and AR technology is of particular interest to designers and architects as potential tools to inform and improve the design and build process.

As smartphone technology advances, the expense of VR hardware will be replaced by cheaper headsets that incorporate smartphones with VR quality graphics. VR invites the end user to explore and interact with a virtual representation of a room, floor or entire building providing a mechanism to highlight elements of a design the user enjoys as well as any aspects they may struggle with. Feedback will improve the final design and functionality for the client, while making the business of designing faster, cheaper and more efficient. A more participatory and engaged approach to creating the environment around us will allow us to imagine what building beautiful might look like. Scale this up, and the possibilities, and benefits, are compelling.

Better decision-making, better design

VR offers stakeholders the chance to make more-informed decisions and helps designers, developers and planners to better understand the way people interact with space, buildings and technology. Making the business case for building infrastructure becomes more sure-footed; investment will be easier to secure if investors can experience

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[1] https://www.gartner.com/smarterwithgartner/3-reasons-why-vr-and-ar-are-slow-to-take-off/

the assets they are being asked to finance and have the assurance that a development's risk is low but quality is high. Designs can be piloted to secure feedback from prospective users to optimise the design and build. Lessons can be learned and success replicated.

Digital technologies can facilitate more inclusive design. Researchers at the Centre for Digital Built Britain (CDBB) are studying VR as a tool to design accessible buildings to meet the needs of people with complex sensory conditions. Built environments which are not inclusive act as disablers[2] to communities with varying needs, including the elderly, children and people with dementia. Modern neuroarchitectural approaches give insight into the use of VR to support the design of buildings, providing a tool to evaluate different built environments and promote aspects of design that encourage greater wellbeing. Tools to deliver a user experience risk assessment[3] open up possibilities of inclusive design[4] that enhances the end user experience. Buildings and infrastructure incorporating sensors will provide valuable data confirming how people use a building and navigate the built environment. This data will provide information to improve asset operation and management and be fed back to designers, developers and planners who will build better.

Less is more

These innovations will help to build a more sustainable future in the face of pressing global challenges. The recent Intergovernmental Panel on Climate Change (IPCC) report Global Warming of 1.5 °C (October 2018) and the United Nations 2030 Agenda for Sustainable Development make clear the need to tread lightly with our carbon footprint and the consequences if we don't – drought, famine, floods and poverty for millions across the globe.

Where we need to build new, we must use less. Digital technologies provide the tools to deliver more capacity out of existing infrastructure and improve the way our assets deliver social and public services. Digital tools and monitoring systems enable buildings and infrastructure to be designed better – more sustainably, using materials according to verified measurements rather than conservative estimates[5]. Research at the Centre for Smart Infrastructure and Construction (CSIC) demonstrates how sensor technologies can create smart infrastructure and the opportunity to build living assets that engage with users and provide valuable data to make better-informed asset management decisions. Smart cities will be designed to manage energy, water and food resources more efficiently and integrated systems will deliver new ways to make more of the resources we have.
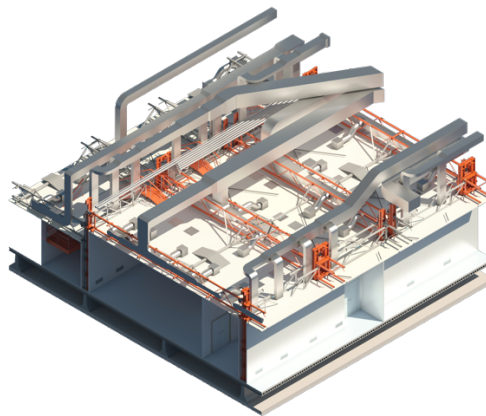
This is a detailed digital model used for stakeholder sign off and 'virtual construction' - from this model components are procured, prefabricated off site and delivered to site in a predetermined sequence for final assembly. Credit: Bryden Wood/GSK.

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[2] Thomas Stone CDBB Mini research project Designing Safe Complex Environments: https://www.cdbb.cam.ac.uk/CDBBResearchBridgehead/2018MiniProjects/2018MP_Bance

[3] https://www.thecentriclab.com/

[4] Arup Cities Alive policyexchange.org.uk

[5] The Cambridge Centre for Smart Infrastructure and Construction: https://www.centreforsmartinfrastructure.com

Tools of the trade

Advanced sensor technologies allow us to understand the performance of the structures we build and to use data to optimise the design, construction and maintenance of our assets. A National Digital Twin, a federation of digital models that will enable better decision making in the delivery, operation, maintenance and use of infrastructure, is within sight; the Digital Framework Task Group (DFTG)[6] is currently collaborating broadly across industry to explore the underlying information management framework for the built environment that will be the foundation for digital twins. The digital tools, standards and processes collectively known as Building Information Modelling (BIM) is at the heart of this digital transformation and provides a critical opportunity to improve performance and productivity in construction. The Centre for Digital Built Britain is the custodian of UK BIM, a collaborative process providing accurate and transparent information using 3D models and a common data environment to access and share information efficiently across the supply chain, reducing the risk of error and maximising the ability to innovate. Innovation and collaboration in construction is vital to future success. The call for more and better housing in the UK demands new and affordable models of housing production and design[7] and this requires radical industry change. While fully collaborative 3D BIM is mandated on government-procured projects, the wider construction industry is still to adopt digital transformation to address problems of productivity, overrunning and waste. Combining BIM with off-site manufacturing will bring real opportunity to improve our capacity to build houses at the scale and quality needed in the UK.

Using an Igloo Vision immersive cave to preview functionality, lighting, and space in a civil design. Credit: AECOM.

Sense of place

Digital technologies invite better engagement with the process of designing our built environment. Greater engagement with the public will drive more participation in the process of developing the houses we need, the cities we live and work in, and the buildings that deliver vital services to our communities. If people are given the chance to make meaningful contributions to the design and function of the built environment, there is opportunity to revive our weary planning system and introduce efficiencies. If building better leads to securing planning permission in a timely manner, the incentive to up the quality and aesthetics of new housing is there for developers. Plans for developments that are supported by the communities for which they are built and developments that give people a sense of place will relieve the burden of resistance on the planning system that leads to costly delays. This will allow people to see and experience buildings before plans are passed or bricks are

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[6] The Digital Framework Task Group: https://www. cdbb.cam.ac.uk/Blog/2018JulyBlogEnzer

[7] Dr Gemma Burgess, https://www.cdbb.cam.ac.uk/Downloads/ResearchBridgeheadDownloads/
BIMandUKHouseBuildingFinalReportforCDBB.pdf

laid, to invite comment and real engagement in the process will surely deliver the wished-for community consent that the Government's new Building Better, Building Beautiful Commission identifies as the prize[8].

Walking through a BIM master model during pre-construction review. Credit: AECOM.

House builders could share data in a secure manner to shine a light on the designs and functions different communities of users prefer to form a better understanding of universal design and accessible architecture. Data could be the gateway to 'building beautiful'. Combine data with VR and AR tools that invite people to virtually try a home, office, housing development, hospital or school before they are built and a door opens for a more collaborative process of participatory design that captures meaningful engagement.

Benefits are clear and we have the digital tools to hand. Will this transformation lead to the building of homes the public find beautiful? Defining beauty is a riddle best left to philosophers. But a house designed to meet our needs, an affordable, sustainable dwelling built to function well, a home in which we would wish to live is, surely, a thing of beauty.

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[8] Building Better, Building Beautiful Commission: https://www.gov.uk/government/publications/ building-better-building-beautiful-commissiondraft-terms-of-reference