Case Study Title: The Lean Approach to Immersive Technology at Arup

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Founded in 1946, Arup is an independent firm and one of the largest multidisciplinary consultancies in Ireland. Arup's designers, planners, engineers, project managers, consultants and technical specialists work across every aspect of today's built environment. With offices in Dublin, Cork, Belfast, Limerick and Galway, Arup provides a broad range of professional services – from designing buildings and infrastructure, to harnessing digital insights and providing strategic advice. Globally, Arup has more than 17,000 specialists working on projects in over 140 countries. Arup is committed to using expertise, creativity, and innovation to shape a better world.

Author

Enda Kirwan

Author

Michael Galbraith

Overview & Background to the Lean Initiative

The Immersive Technology team at Arup uses design data to create visual models of building and infrastructure projects to aid communication, engagement and decision-making processes when interacting with investors, policy makers and the public. Using real-time game engine software, the team currently utilises all aspects of interaction design within extended reality (XR) to create user-friendly experiences. Our approach is fluid – we often use technology and techniques from industries outside of AEC (Architecture, Engineering and Construction) to showcase the best of project design data and offer clients a new perspective on their projects.

Key benefits of immersive technology:

- Unlocks the potential for multidisciplinary collaboration
- Strengthens bids and communication of design ideas
- Uses lean methodologies to help make more informed engineering decisions
- Facilitates better planning throughout the project lifecycle
- Enables safer training of field teams
- Improves project coordination efficiency
- Optimises the operation and maintenance of BIM models

Immersive technologies enable projects to be presented in a holistic, dynamic and visual way, improving overall quality of projects and services before designs are made a reality, and crucially, before mistakes may be 'built-in'. Presenting the highest standard of work to our clients is a fundamental part of what we do.

Lean Initiative Undertaken – Lean Thinking, Tools, Techniques

In 2018, in line with the digital transformation of the construction industry, we started looking for new ways to improve project efficiencies and deliverables. Our teams were having difficulty visualising 3D environments in complex projects – design is ultimately about a full sensory experience, something that is hard to predict or model when relying on 2D drawings alone. We realised digital techniques presented an opportunity for improved coordination, design team communication and collaboration, which would help cut down on time and costs spent on rework and resolving of issues. Extended reality technology and tools allow designs to be taken off the page, enabling prospective owners, developers and users to explore and understand different design options whether they are for a new road, train route, bridge, building, public space, cycling lane or bus route – the options are endless.

Colleagues in the London office had been working with extended reality tools for quite some time. They had developed a virtual space where engineers, technicians and designers could fully interact and collaborate with their designs and project teams, and were using the space to turn the design and engineering process into an experience that non-experts could understand and participate in. Collaboration with this team gave us the full understanding needed to share the skills from the UK to Ireland and our other offices across Europe.

Convinced of the benefits of immersive technology, we established an Immersive Technology team and invested in the hardware with a new extended reality facility, the HIVE (Human Immersive Virtual Environments), being built in the Dublin office. The HIVE is equipped with a high-powered rendering PC, two large 4K screens, virtual reality head-mounted displays with motion tracking, a lighting wall, bespoke furniture and controlled lighting with motorised blackout blinds. See Figure 1.

The success of the HIVE depended on buy-in from design teams. It was promoted throughout our offices in Ireland and globally as a collaborative, real-time immersive space for innovation, one that would enable teams to navigate buildings or transport infrastructure without leaving the office. Lighting designers could demonstrate the environmental impacts of lighting in areas of conservation. Importantly, through virtual and augmented realities, we could now

offer better user experiences to our clients and project stakeholders, enabling more informed decision making.

Figure 1: The HIVE (Immersive Virtual Environments)

While internal promotion and communication was vital to win work at the beginning, the word of mouth has spread since this technology has been mobilised on projects. As our library of case examples grow, so too does our understanding of the technology at Arup. This means that an increasing diversity of teams seek out this service. Since opening at the beginning of 2022, the HIVE has facilitated countless design team project review meetings. The Immersive Technology team can now transform existing BIM data into real-time models using software from the gaming industry and then use virtual reality as a viewing platform. Designers can navigate through their model, identify any issues with multidisciplinary clashes, highlight the issues in the virtual model and distribute the clash reports to the relevant design team members to resolve. The technology also supports experience-based decision making by enabling teams to experience scenarios associated with their projects and make better informed design choices together. Extended reality experiences allow us to communicate designs with our clients in ways that were not possible in the 2D environment. We explore what a solution will feel like for end users, whether they're residents, audiences, commuters, or anyone else.

Lean Initiative Improvements & Impact

Establishing the Immersive Technology team in 2020 and opening the HIVE in 2022 have had a significant positive impact on our projects through better informed decision making, bespoke user experiences, client collaboration and efficient coordination between multidisciplinary design teams. Although we are at the early stages of implementing immersive technology through the HIVE, the team has adapted to project workloads and deadlines and invented innovative ways to streamline the workflows used to replicate the virtual environment experience.

Our Automation champions have lent their expertise to assist with the BIM to real-time pipeline. They have developed scripts that automatically export detailed building information models to bespoke outputs that the real-time engine can process. This has had an immense impact on the production of real-time models, significantly reducing the time taken and associated cost.

Many projects worked on this year in the HIVE were already under construction. Going forward, the aim is to use the HIVE at early project stages, allowing greater opportunity for design changes before breaking ground. We are currently developing guidance to better equip our teams for discussions with clients about this service. The aim is to make the material clear and accessible to ensure anyone who reads it understands the possibilities, regardless of whether they have a technical background or not.

To mobilise every discipline on using the HIVE, early career members from each team were designated as 'HIVE champions'. These HIVE champions were trained to operate the technology and shown the use cases by members of the Immersive Technology team. The HIVE champions can now use the HIVE across the wide range of projects at Arup in Ireland, directing more complex or bespoke work to the Immersive Technology team, as required. This has enabled greater numbers of people to use and provide feedback on the HIVE, resulting in various improvements to functionality and training processes, as well as more knowledge sharing and collaboration between project teams.

Figure 2: Construction Site that used the HIVE

Summary and Lessons Learned

The possibilities are exciting. Using immersive technology, we can view the precise placement of materials and services; let clients walk around a proposed design long before a single brick is laid; and use new tools that let asset managers operate key building systems with virtual controls. The power of extended reality is not simply about visualising or sharing proposed ideas with clients and the public. We believe it leads to greater empathy within the design process itself, helping technical specialists to assess human responses to choices of materials or the form and structure of proposed designs.

The HIVE has become a centre of excellence at Arup in Ireland, allowing multidisciplinary teams to interact in the same virtual

environments. In the first year, we have noticed improved efficiencies and a reduction in the need for reworking, as issues can be identified and resolved at an earlier stage through the use of immersive technology. This helps to ensure that projects remain on programme. Our project teams are acquiring broader knowledge and competencies, expanding their current skillsets to prepare for future opportunities.

Client feedback has been positive. The HIVE acts as a simulation tool to showcase our wide range of expertise, from structures to acoustics to lighting to experience design, bringing new insights and confidence to the earliest stages of the design process. It brings new rigour to every element of design, ensuring projects stay both ambitious and grounded, and that schemes harmonise with the communities and contexts they join.

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