2023

Virtual Industry Visits

Cian Farrell
Technological University Dublin, Ireland, cian.farrell@tudublin.ie

Funder: This research received no external funding

Virtual industry visits

CIAN FARRELL
BEng(Hons), MSc, DIC, IPMA-D
Lecturer in Structural Engineering, School of Civil and Structural Engineering, Technological University Dublin, Republic of Ireland

SYNOPSIS

Cian Farrell of Technological University Dublin describes a virtual educational approach trialled during the Covid-19 pandemic to engage students during a period of remote learning and educate them on industry processes and practices. Virtual industry visits saw students receive online briefings and tours of manufacturing plants and construction sites from industry representatives to complement their taught modules. The virtual visits have continued since Covid restrictions eased as part of a hybrid approach to learning that increases student exposure to real-life projects.

The initiative won the Institution of Structural Engineers Excellence in Structural Engineering Education Award in 2022.

Introduction

In the midst of the Covid-19 pandemic, academics found themselves reminiscing over the educational approaches that were trialled during the virtual learning period. Receiving a high engagement rate from student groups was next to impossible for academics during the period of social, mental and educational isolation.

However, with every misfortune come opportunities. In the field of academia, they became evident by stepping into the shoes of the student under the three criteria mentioned above. In this report, the reader will see the phrase the 'Thrill of Engineering', which is a benchmark term used to reinforce the importance of teaching a topic from first principles with much more than a PowerPoint presentation.

While lecturing (educator) in structural engineering at Technological University Dublin and founding start-up business CTFL Global (educational consultancy and supplies), the author was involved in trialling and monitoring several virtual learning methods. Two key methods were *virtual industry visits* and the construction of a *virtual learning structural engineering laboratory*.

The virtual industry visits are the main educational approach to be discussed in this report. The virtual learning structural engineering laboratory is part of CTFL Global.

Virtual industry visits

A virtual industry visit (VIV) is an educational approach that involves the educator travelling to an industry firm and delivering an interactive documentary-like virtual learning event for student groups. The VIV event acts as a reinforcing tool for the content being taught in class and it is essential to start communicating with the industry firm as early as possible to maximise the learning benefit from the event. Over a 12-week semester burdened by Covid-19 restrictions, the following VIV events were delivered by the educator:

- Modular Design, Manufacturing & Installation
- Structural Steel Design, Manufacturing & Installation
- Precast Design, Manufacturing & Installation
- Cement Design & Manufacturing (Including quarrying of raw materials)
- Timber Manufacturing & Harvesting.

For every VIV event, a structured delivery plan was prepared to ensure that all learning outcomes were achieved. Developing this well in advance allowed both the educator and the industry professionals to plan how they would deliver the concepts to the students, and also to take time to consider additional learning outcomes that might be achieved.

A typical structured delivery plan is outlined below:

Step 1: A lecture covers the first principles of the topic, which is part of the original course. On completion of the lecture, two short quizzes are held to monitor the engagement rate and level of understanding from the student group. This step is delivered from the place of industry (i.e. boardroom).

Step 2: After the lecture, an introduction to the firm is delivered by a representative of the firm, followed by a health and safety briefing **(Figure 1)** and a Covid-19 briefing.

Step 3: On completion of Step 2, pre-agreed core station conversations and demonstrations **(Figure 2)** are held with engineers, draftsmen, procurement officers, sustainability officers, and the managing directors/owners of the firms. An in-depth synopsis of each person's role and responsibilities is covered in this step as well as how they interact with other in-house departments and external bodies on a day-to-day basis.

The demonstrations carried out in this step enable students to better interpret how industry professionals come to an engineered product or design (e.g. modular construction, prestressed concrete, structural steel), the software packages used by the firm (e.g. engineering, BIM, QS software packages), and the standard processes according to which the firm operates (e.g. whiteboard session delivered by the managing director/owner).

Step 4: After completing each core station from Step 3, a step-by-step explanatory tour of the manufacturing plant is delivered by the educator and plant manager/operations manager. This typically starts where the procurement officers have purchased material and are now ready for manufacturing based on the engineers' or draftsmen's

FIGURE 1: Safety briefing being delivered by safety officer

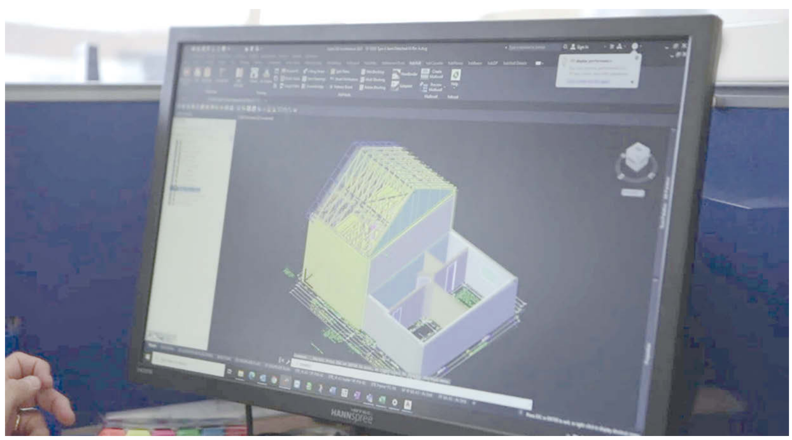

FIGURE 2: Demonstration in Technical Department of modular construction firm

FIGURE 3: Discussion with Senior Materials Engineer on breakdown of cement ingredients

output (e.g. product drawings, product specifications, manufacturing steps for bespoke products). This step starts in the raw materials storage region and progresses through the manufacturing steps until the final product is complete.

In-depth discussions **(Figure 3)** are held around the grading and certification of products and how these properties have been established (e.g. structural timber boards – C16 boards, cement grades, concrete grades). Some examples of where this can be demonstrated to students include concrete cube testing, three-point testing of timber boards and discussions around grading machines, thermal and air-tightness testing of final developments on site.

Step 5: With the final products being manufactured at this stage, discussions and visual inspections are carried out before the products are moved to the loading bay for delivery to site **(Figure 4)**. Discussions typically address product finishes (e.g. fair-faced concrete, timber finishes (rough/planed), steel paintwork and detailing checks), Building Regulations compliance (e.g. modular construction), comparisons between software models and the practical products (e.g. precast beams, steel beams), cranage points for loading/unloading, and health and safety.

Step 6: Once snagging of the final products is complete, the next step is to watch a standard delivery truck being loaded followed by a discussion of the Road Safety Authority's (RSA) regulations regarding delivery truck weights and sizes. Implications arising from irregular loads and tight sites are also covered in this step through discussions and demonstrations around the logistics plan. A key example of where this became visually clear for the students was when the educator and media crew followed a 46m long prestressed bridge beam to site **(Figure 5)**.

Step 7: This involves the erection of the manufactured products on site. Discussions are held with site engineers, site coordinators, and installation managers. Discussions cover the initial scheme plan for dropping off and unloading trailers, traffic around the site, the installation of the products on site, and finally the grading and snagging of workmanship on site.

A full demonstration was carried out on all VIV events of the final products being installed on site **(Figure 6)**, ensuring continuity and completion of the first principles taught.

Step 8: Q&A sessions are held for the student groups with representatives of the firm that that took part in the VIV event **(Figure 7)**.

Step 9: A comprehensive quiz is held for the students on the VIV delivered to monitor engagement and their level of interpretation of the event.

Engagement and interaction

The VIV events were held for multiple groups of students taught by the educator, as well as groups of students who were taught by other academics who employ the educator as an educational consultant. This section will discuss student engagement and interaction from the student groups taught by the educator, and then look at industry's contribution to the VIV events delivered.

Student engagement and interaction

As mentioned previously, it was extremely difficult for academics to

FIGURE 4: Discussions related to final products and delivery truck limitations

FIGURE 5: Delivery of 46m long prestressed concrete beam

FIGURE 6: Installation of wall panels in residential development

generate engagement and interaction from student groups using traditional educational approaches in a time of social, mental and educational isolation. Those three pillars, which form the backbone of a positive learning environment, were no longer present in the virtual learning world.

Academics were forced to take immediate measures not only to support their students' educational development, but also their social and mental well-being. In the absence of that green psychological state providing a sense of emotional equilibrium, students' focus and ability to absorb educational content was greatly impacted, which in turn caused a lack of bonding and teamwork within student groups.

The VIV approach was much more than just an educational approach; it was a tool to help break the students' accumulated barrier of both fear and comfort in not interacting in class. Tackling this issue required a complete restart to distract the students and to break their comfort zone of not interacting.

The transition had to be done with pace and power – and the educator introduced the 'Thrill of Engineering'. Whether it be loud, roaring machines, high towers swaying in the wind, explosions from the mining of quarries, or the tensioning of prestressed concrete beds, this excitement and thrill introduced through the educational approach gained the full attention of all students.

At the end of each VIV event, almost all students interacted in the Q&A session, with questions aimed at all aspects of the VIV delivered. After the Q&A session, a comprehensive quiz was used to examine the engagement rate of the students, asking both technical and engagement-monitoring questions. The results of the final quiz (Step 9) were compared with the two short quizzes completed during the initial lecture (Step 1). The average results for the group's performance are presented in **Table 1**.

An average increase in grades ranging from 13.8% to 18% was recorded from the quizzes completed by the students in Step 9 compared with Step 1 (overall average combining two quizzes in this step).

In addition to monitoring the engagement and interaction of the student group, direct feedback was requested from the students. Comments included: 'I enjoyed how educational and how simple everything was to understand considering the complexity of the profession'; 'It was a great addition to our module and brings back some sense of normality at these strange times'; and 'This was such an informative and superior way of learning compared to my normal daily classes. I truly enjoyed it and feel as though the information I've learnt will stick with me better than many other lessons'.

Industry engagement

The educator received a warm welcome when reaching out to industry firms during the remote working period. All firms involved made an incredible contribution, whether providing an industry professional's time, or resources to help facilitate the events.

The key to delivering an effective VIV event is to start communicating with the firm at least three weeks prior to the event. This enables the educator and industry professionals to start preparing a structured plan containing the learning outcomes that need to be achieved during the event.

Early engagement also enables the firm to start thinking about how it would like to showcase the processes and

Table 1: VIV learning monitoring results for five events (average results for student group)

Virtual industry visit	No. of students present	No. of students who interacted in Q&A	Quiz marks from Step 1 (%)	Quiz marks from Step 9 (%)
Modular Design, Manufacturing & Installation	38	38	68.5	82.3
Structural Steel Design, Manufacturing & Installation	37	37	70.1	84.2
Precast Design, Manufacturing & Installation	39	38	63.4	80.4
Cement Design & Manufacturing (including quarrying of raw materials)	38	32	55.8	73.8
Timber Manufacturing & Harvesting	39	39	63.8	81.4

structure it follows on a day-to-day basis. Examples include how it ensures sustainable working, incorporates renewable energy into its business, BIM integrations that it has adopted, or even specialised equipment that it would like to demonstrate.

After the VIV events listed earlier had been run, it was clear from the industry firms visited that more interaction between academia and industry is highly desirable. A lack of continuity between the educational content being taught in class and everyday industry norms is a major issue in the field.

With engineering projects becoming more complex and fast-paced every year, one managing director said, 'It takes approx. 18 months before you have a graduate that really knows what they are supposed to be doing, early interaction is certainly desirable from our point of view'.

This once again opens a field of opportunity within academia to try and implement some form of hybrid solution that both teaches the fundamentals of the topic, but also obtains the industry intelligence that prepares students for real-world industry roles.

Utilising this educational approach in the future

After the easing of pandemic restrictions enabled in-person classes to resume, further evaluation of the educational approach was carried out to examine how beneficial it was in everyday engineering education. Previously, all students studied remotely full time, so dialling into a VIV was the same as dialling into an everyday lecture. The question now is whether there are still opportunities in the field of engineering education for the new educational approach.

Some universities have continued to deliver online modules as a result of their findings from the remote working period. This has especially been noticed for the later years of bachelor's degrees and postgraduate degrees where a high number of self-learning hours are required. With this continued remote learning approach for the above-mentioned student levels, the development of standard skills required to study a third-level programme has been assumed to be established by academics at this stage of study. As for the more junior years, a more hybrid option embedding the 'Thrill of Engineering' concept could be the answer to tackling the high level of student dropouts every year.

Since students returned to the classroom, many VIV events have been held for the educator's student groups and for other academics' student groups. For engineering topics that consist of a body of content ranging from theoretical derivations to practical applications, the educational approach described has proven to be extremely useful.

In teaching such content, practical demonstrations and laboratory testing have always been a key tool to enable students to better interpret the concept. However, through the application of the VIVs as part of a hybrid teaching solution, that bridge between classroom textbooks and industry intelligence has enabled students to visualise and interpret how the concept applies in industrial reality.

↓FIGURE 7: Open Q&A session at end of VIV event

Some example modules where the VIV approach has been applied are for bridge engineering, earthquake engineering, construction technology, and geotechnical engineering.

An example of a VIV event was a 'visit' to the 1915 Çanakkale Bridge in northwest Turkey. This involved completing all the steps listed in the delivery plan earlier, with the only real difference being that the educator remained in the lecture hall while their colleague and media team travelled to Turkey to coordinate and deliver the event. Discussions with the engineering firm started five weeks before the event, which enabled a high level of planning and coordination.

Another example was a 'visit' to the southern coast of Portugal as part of a 'Coastal Erosion and Sea Structures' topic taught by the educator. The educator delivered the VIV offshore using a boat and kayaks to take a closer look at some sea structures.

With this ongoing blend of realism and excitement, the educational approach continues to act as an investment that not only reinforces the principles being taught in class, but also opens students' eyes to the opportunities that the profession has to offer and guides them in their career paths.

In forming such a bond between academic studies and industry realism, the field of engineering education has an opportunity to present itself as a resource for developing industry-ready graduates, as well as acting as a key problem-solver for everyday industry problems.

It was essential for the limitations of an event to be determined in advance to ensure maximum safety was maintained. An example safety measure that was introduced was to use drones to film essential learning outcomes, such as visual inspections of the bridge piers of the Çanakkale Bridge, and unstable sea structures along the southern coast of Portugal.

Discussion and conclusions

With academics finding themselves back on the more common ground of in-person teaching conditions, the re-evaluation of educational approaches adopted during the pandemic has proven to be quite informative. In doing so, educational innovations have begun to present themselves as potential hybrid tools that can be used within everyday engineering education.

As mentioned previously, the VIV approach set out to be much more than an educational approach. With students having been encased in a mindset of little or no participation, it has proven its ability to distract from and overcome the fear and comfort zone developed during the recent period of social, mental, and educational isolation. Its inherent property of generating a positive learning environment made the educational experience much more enjoyable for the students, which in turn led to an improvement in their performance.

Monitoring the engagement and interaction of the student groups in the VIV events, the initial quizzes, Q&A sessions and final quizzes enabled the educator to examine how successful the events really were. As outlined in Table 1, an excellent rate of engagement was achieved during the Q&A sessions, while a 13.8% to 18% increase in the average results was recorded for the final topic quizzes. This demonstrates that, by providing students with real-life practical learning experiences that are driven by the hybrid delivery model involving academia and industry intelligence, remarkable results can be achieved.

While in-person studies have resumed, this educational approach has been called on as a very useful hybrid tool providing an opportunity for academics to incorporate industry intelligence for projects or case studies in any part of the world. It also acts as a benchmark for industry to have their say in the educational content being delivered in modules, preparing students for an increased rate of progression when they begin their new graduate roles. It comes with an investment from the field of academia and industry firms in contributing valuable time and money for the next phase of engineers to reach industry.

It has been noted several times throughout the report that for a successful and effective VIV event to be delivered, communication with industry firms should start as soon as possible. Early discussions and a detailed, structured plan outlining the key learning outcomes gives both parties time to develop delivery methods for the concepts to be taught during the event.

In conclusion, the educational approach of VIV events has proven to be an extremely useful tool for breaking down barriers of little or no interaction within student groups, while greatly increasing the interest and curiosity of students studying engineering modules. Its application as a hybrid teaching tool provides students with direct real-life projects and case studies that reinforce the concepts they find themselves trying to break down and interpret.

HAVE YOUR SAY

tse@istructe.org

@IStructE
#TheStructuralEngineer

#TheStructuralEngineer