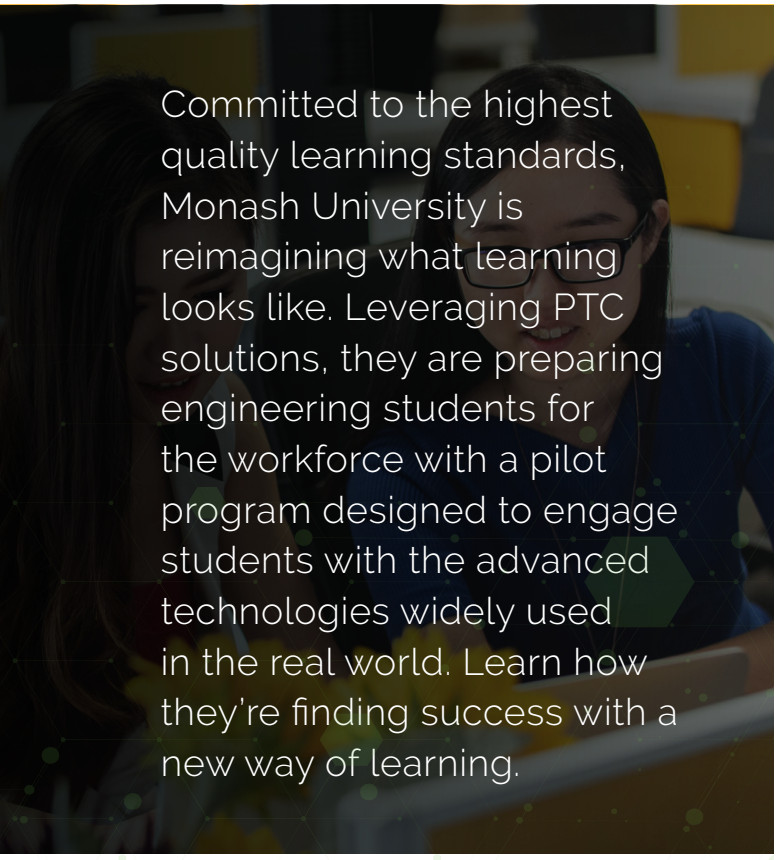
IoT is Enabling Digital Twins to Enhance Learning Experience at Monash University

Augmented reality expands access to facilities via realistic, remote learning opportunities



Real-world learning experience is critical for student development

Student and industry feedback from engineering degree programs has shown there is increased demand for exposure to real-world engineering projects with industry relevance. Graduates also tend to lack knowledge and appreciation of the benefits of Industry 4.0 and digital technologies.

At Monash University, there is a focus on providing students with opportunities to use new digital technologies that are becoming increasingly common in industry, such as simulation, digital twin, Internet of Things (IoT), and augmented reality (AR).

Delivering authentic student learning experiences

While planning The Monash Engineering Student Pilot Plant, academic staff at Monash University

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saw an opportunity to apply PTC's Industry 4.0 technology to deliver a more authentic and accessible student experience for those studying the Bachelor and Master of Engineering courses. The program is designed to help students gain hands-on experience interacting with and operating an industrially relevant process—in this case, water treatment.

The demonstration plant, based on membrane technology for water treatment, will feature IoT devices, an AR experience, and a digital twin to demonstrate how these technologies can enable wide user access, improve existing processes, improve operator training, and enhance planning for broader process optimisation.

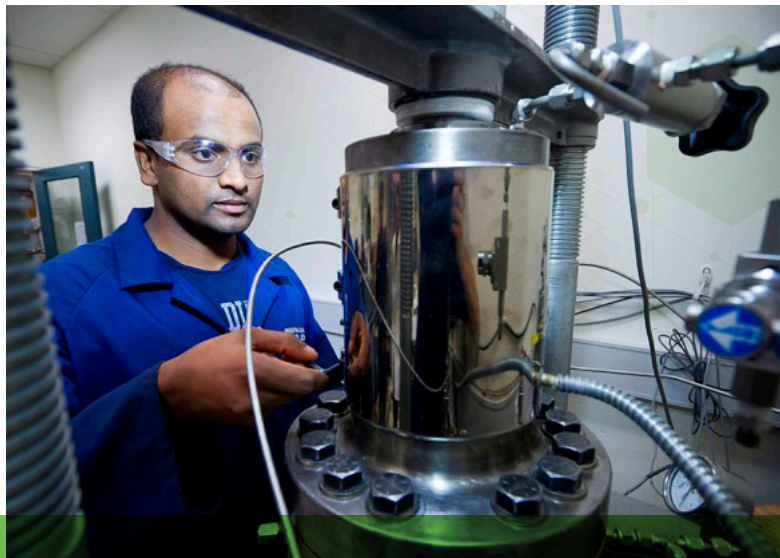
The Monash Engineering Student Pilot Plant and associated Industry 4.0 technologies are designed to be representative of industrial experiences and needs. One example of the use of the digital twin may be the need to increase capacity without any increase to the footprint of a plant. A digital twin can facilitate improvement of the efficiency of existing process and perhaps inform an upgrade or an augmentation to the existing system in the most efficient, most economical way. Digital twins are also hugely beneficial as teaching and training tools, enabling remote access, process simulation, and scenario-based activities.

Addressing issues with existing technology

The vast majority of process and manufacturing industries deal with water treatment, either as their core or an ancillary process. Water treatment was therefore chosen by Monash to demonstrate in their Student Pilot Plant due to its wide technical applicability to industry. Students who interact with the pilot plant during their studies will therefore all graduate with authentic, practical experience that they will be able to apply in their professional careers.

An additional issue is that university labs typically involve physical equipment which has limitations in terms of scale, accessibility for remote students, and capacity for students to work simultaneously. The inclusion and focus on digitalisation technologies, including remote access, simulation, and digital twins, will remove these bottlenecks, creating an accessible, inclusive experience for all students.

The Student Pilot Plant also represents an opportunity for technological advancement of industrial water treatment processes. Few instances of online, real-time optimisation exist in water treatment processes, which are typically low margin processes or negative value waste treatment processes to meet disposal and regulation requirements. The adoption and implementation of Industry 4.0 and digitalisation technologies in water treatment is limited. Whilst existing SCADA/DCS systems available in typical water treatment plants do offer automated control and remote access, this is predominantly regulatory control with heavy reliance on operator input and experience.



Highlighting a digital twin solution

A digital twin-based solution is expected to provide opportunities for teaching, training, and broader process optimisation, such as automating optimisation tasks and removing the need to rely on operator experience and specific operator knowledge and decision making.

The Monash Student Pilot Plant will serve as a demonstration of such digital twin technology implementation. It will be an educational tool for students and industry professionals, showcasing process automation and operation and using the digital twin to provide a functioning example for learning, teaching, and research purposes within the university, as well as demonstrating the feasibility of a functional digital twin to showcase to potential future industry partners (both in water treatment and other processes and industries).

IoT data will flow from physical devices such as control valves and flow meters on the pilot plant to the digital twin, where it will be analysed and interpreted by AI and machine learning to provide complex data analytics and online process optimisation. It will also increase the potential for data use in offline simulations to enable case studies and provide additional insights into complex processes.

Following feedback from various stakeholders, Monash sees the opportunity for benefits from an on-campus, remotely accessible, combined physical and digital water treatment pilot plant to students and industry to include:

- Training - use of digital twin for online, AR/VR-based familiarisation and training for students and industry professionals
- Design - creation of new assets and design of expansions and capacity increases for existing assets
- Advanced control and automation - integration of AR, IIoT, smart sensors, etc.
- Online process optimisation - integrated digital twin with two-way data transfer for process optimisation over longer timescales than are typically expected of human operators
- Offline process optimisation - scenario-based/case study investigations for troubleshooting, process improvement, optimisation, and efficiency improvements—testing edge cases, in particular
- Integration with enterprise systems - use of the digital twin/outputs from the digital twin to perform optimisation activities at higher levels of the business without disturbing the operating process
- Business currency, social aspects - helping industries to attract talented individuals and to be viewed as technologically up to date

Monash University partners with LEAP and PTC to engage students in new ways

Monash is working with LEAP and PTC for the initial AR and digital twin project, leveraging their existing relationship and demonstrable experience in the relevant digital technologies, plus their ability to help rapidly deliver an authentic experience for students and industry by combining IoT and AR with the Monash Engineering Student Pilot Plant.

AR experiences are currently being created in Vuforia Studio to facilitate visualisation of proposed plant equipment before installation.

Those experiences will be connected to the Thingworx IoT/digital twin platform and Ansys simulations to create an AR-based Human Machine Interface (HMI) to expand on-site accessibility to the physical equipment via remote and simultaneous access to the digital twin.

During the initial planning stage, use of AR is allowing Monash staff to rapidly showcase the 3D models of the pilot plant at true scale in the planned physical space. The creation of this initial AR experience was completed within a timespan of just a few weeks (while it is typical to wait many months for physical equipment to be installed). Training and teaching activities using AR, both with and without connection to the physical equipment, are also being planned in the meantime.

Looking forward, the integrated physical and digital systems will enable students to gain an appreciation of how digital technology interacts with industrial processes. Using AR connected to the digital twin, students can conduct remote walk-throughs of and interact with the entire process to provide them with a deeper understanding of the process and equipment.

Choosing PTC's IoT and AR technology highlights key benefits

The digital twin and associated technologies that are being developed by Monash are expected to showcase the advantages of digitalisation technologies and rapidly facilitate the enhanced learning experience of hundreds of students per week. The students will be interacting with the IoT data and digital twin of the Monash Student pilot Plant via remote access and AR experiences.

"ThingWorx and Vuforia are a perfect fit for what we are trying to achieve, thanks to strong technical capabilities and ease of use with a quick learning curve," explains Dr. Joanne Tanner, Department

of Chemical Engineering at Monash University. "Since the Vuforia AR solution is built on top of ThingWorx, we are also excited about the ease of building a combined IoT and AR experience without the need for any extensive programming or IT knowledge, potentially making this platform a great way for students to be involved in developing the digital twin."

The new solution enhances learning for hundreds of students each week

For the university, this digital solution will provide an ability to remove bottlenecks from physical equipment used in laboratory teaching. Digital twins combining IoT and AR have the capacity to provide an enhanced learning experience for many hundreds of students per week, which avoids the usual capacity limitations when students are accessing limited physical equipment. It is also expected to provide a more authentic user experience for student engineers, mimicking the way in which they will interact with processes in industry via control systems and process simulations for online and offline training, design, and optimisation.

The future is bright for Monash engineering students

The staff plan to expand the Monash Engineering Student Pilot Plant to include a larger suite of industrial processes, including biological engineering processes. They will also implement always-available remote access to the pilot plant digital twin to facilitate self-directed learning. An extension of these tertiary teaching activities will also include industry demonstrations, training, and short courses.

With these new learning opportunities, Monash engineering graduates are sure to have bright careers ahead—and the university is eager to continue expanding these new learning paths for generations of engineers to come.