July 27, 2021

Peer-to-Peer Network Forum:
Augmented-, Virtual-, and Mixed Reality in Manufacturing hosted by Conexus Indiana

Summary

Conexus Indiana hosted a Peer-to-Peer Network Forum on Tuesday, July 27 to explore emerging use cases in manufacturing and logistics for augmented-, mixed-, and virtual reality. Samtec and Rolls-Royce provided insights into their journeys with these technologies, sharing specific examples in electrical connector manufacturing and aerospace and defense. Subject matter experts from ten organizations with an interest in AR/VR/MR participated in the peer-to-peer discussion.

Samtec kicked off the event with a presentation on three distinct AR/VR/MR use cases:

- **Virtual reality training for Samtec employees applying epoxy (glue) to small, electrical connectors**. Samtec's use of 3D visualization combines a headset and software built via Unity Technologies' suite of tools. The team designed virtual reality training to help employees learn the correct way to apply epoxy at three levels of scale: 30x magnified, 10x magnified, and actual size. Because the epoxy application is a precision operation at a tiny scale with little margin for error, this training approach enables Samtec employees to acquire the necessary skills in a methodical and measured way, starting at a level of scale that is physically less challenging. Employees can learn the skill and nuance of keeping their hands steady long enough to accurately apply the glue to the connector, and as they improve, the difficultly level is increased until it matches the real-world requirement. Because this was the first implementation of virtual reality training at Samtec, there was a steep learning curve, and implementation took about 1 year. Challenges included modeling and visualizing fluid physics and dynamics in the headset, and even how to build objects like virtual cameras to simulate using cameras in the real-world application. Ultimately, the virtual reality training solution has saved Samtec thousands of dollars on the cost of scrapping products that would be rendered useless during physical training sessions and reduced the duration of training sessions to just 60 minutes total.
- **Augmented reality training for Samtec's technicians through Microsoft HoloLens.** This use case presents 3D visual overlays of 'pop-up' information boxes (holograms) to technicians wearing the HoloLens. The holograms are presented to offer real-time access to the right information at the appropriate places and times while technicians work through the process of tooling change-overs for production machines on Samtec's factory floor. As the technician executes the workflow, information is made available in the form of documentation, images, 3D holograms, and videos. This information is part of a library that Samtec had to assemble and curate, often with the use of a GoPro to capture a video of an expert completing the tooling change-over. A

key benefit stated by Samtec is that all employees now get the same training experience at the highest level of quality.

- **Virtual reality facility tours**. The application was built by the marketing team at Samtec. The use case was primarily a result of the COVID-19 pandemic, as the company could no longer bring others into the facility for sales. The team remarked that it has been a tremendous success and will continue to be leveraged beyond COVID-19.

Rolls-Royce followed Samtec with a presentation on AR and VR for design, assembly, and maintenance. Specific use cases were explored at each stage of the product 'life cycle.'

- **Design: VR Design Reviews.** Rolls Royce leverages VR for its design review process to conduct full layout reviews in virtual reality. As Rolls-Royce tested the VR design review use case, the team discovered several more design opportunities beyond the initial project scope. In some cases, design errors could be corrected before they became costly mistakes in the real world, and ultimately led to more than a million dollars of estimated savings. Rolls Royce now leverages this VR design review technique throughout the design process.
- **Design: AR fit checks for mock-ups**. Rolls-Royce uses AR to overlay mock-up designs into reality for a 'fit check' to test how new designs align with physical versions of the larger system(s). Design errors are often not noticed in CAD because CAD typically simulates 3D from a 2D image using effects like shadowing, which can lead to optical anomalies and perception distortions. True 3D visualization can reveal much more about how a part or component is going to fit into a larger system. Rolls Royce has been able to avoid manufacturing a physical prototype or part via 3D printing because as design errors are discovered in the software, the AR prototype designs can be changed on the fly.
- **Build: AR for work instructions/VR for assembly training**. Rolls-Royce uses VR for employee training on production assembly and AR for work instructions, much like Samtec. The team found that these solutions not only led to improved efficiency in training but also increased retention of the new information. Training programs that leverage AR and VR also lower barriers for new employees, enabling those with less knowledge or experience to onboard rapidly into assembly positions. In other words, VR helps employees gain experience to a point where they can complete a task via training and AR work instructions assist employees so that they don't need to know as much in order to be capable. The AR work instructions also removes quality escapes and improves worker efficiency.
- **Maintain: Virtual reality maintenance training.** The VR solution enables field technicians to practice maintenance tasks before they perform tasks on real engines, resulting in better quality and consistency. The solution is developed with several software platforms and a hardware combination of HTC VIVE Pro and Leap Motion. The core challenge Rolls-Royce solved with this use case is that experienced maintenance technicians in the field had not gone through a rigorous and detailed training program on the specific engine they encounter in the field. Training programs have traditionally been held at central locations, where physical engines are located, and often there is not a budget

for training-related travel to bring technicians from around the world to these engines. The result is that training can sometimes be limited to older or different versions of an engine and the technician is left to translate and apply general concepts to the actual engine they are assigned to. With VR, Rolls-Royce can bring a virtual version of the correct engine to the technician in the field and train them on the exact procedures for maintenance.

- **Maintain: AR for remote assistance.** The solution enables employees performing a maintenance task to dial-in for remote, expert help and gain real-time access to assembly instructions. The connection is enabled through Microsoft Teams via MS Dynamics 365 remote assist. Employees can also connect for remote help in VR; however, it's only accessible to those with specific VR training software installed.

Shared Learnings

- **There is a tremendous amount of documentation and content development required for AR/VR/MR implementation, but the process of developing it adds value.** Both Rolls-Royce and Samtec mentioned that going through the process of building a new AR/VR/MR solution opened the door for creativity to improve existing manufacturing processes, like quality assurance. These discoveries, namely new areas for process improvement, were only made possible through the rigorous documentation of AR/VR's role in the manufacturing process (Samtec mentioned that hundreds of new videos and written documents with images were created, and now serve as a 'one-stop-shop' for process documentation). Even though documentation and content creation are large costs in terms of labor (estimated to be up to 50% of a designer's/developer's time), developing it provides value in and of itself, even if the technology is never deployed.
- **Secure buy-in from leadership with standardization benefits across and organization**. Rolls-Royce and Samtec both discussed a key selling point of AR/VR: the creation of a standardized approach to employee training and maintenance procedures. A new level of standardization across an organization can be achieved through AR/VR solutions as they remove variability in these processes and ensure every employee gets the same high-quality training experience.
- **Budget for research and development and explore pilot opportunities for emerging technologies**. Companies shouldn't require a rigid ROI for the early steps of exploring emerging technologies because the fruits of implementation may not be obvious at first glance. In the case of the AR/VR adoption projects at Rolls-Royce and Samtec, the full benefits of the projects were not realized until the solution had been developed and implemented. Cost savings, process and design improvements, employee retention, etc., were not immediately thought of as potential benefits. Had early exploration been subject to rigorous ROI analysis, the technology may not have been adopted, and these benefits may not have been discovered.
- **The right use case(s) for AR/VR/MR might be unique for your organization or industry**. A company should have an approach for implementing Industry 4.0 technologies or technology roadmap to uncover the

best use cases and figure out how to leverage this relatively cheap software. Some examples include using 3D visualization for modeling heavy machinery, reducing waste from parts and tools that would otherwise need to be scrapped after an employee has been trained on them, or conducting hazardous waste training without the need for employees to physically handle the chemicals. There are many possibilities, and the right one to tackle first is dependent on an organization's unique situation.

- **Development & implementation costs for the first AR/VR/MR solution might be relatively high, but the resources and timeline required for the second and third projects fall dramatically.** The initial development of an AR/VR solution will be on the higher end due to the combination of in-house development costs (employee time and labor) and/or development through a 3rd party. But companies that are committed to the adoption of these solutions will start to create expertise as well as a library of reusable pieces, plug-ins, and hardware to keep building new solutions. In many ways, AR, VR, and MR are exponential technologies, meaning they are on a curve of becoming cheaper, more powerful, and more accessible with new and constant software and hardware updates.

Next Steps

Conexus Indiana is incorporating feedback and perspective from the discussion in an ongoing dialogue with participants, which may result in an annual or bi-annual AR/VR/MR working group for our network.

Get Involved

Conexus Indiana's Peer-to-Peer Network is an invite-only forum for Indiana manufacturers and logistics companies to share knowledge and best practices about Industry 4.0 technologies. Reach out to Conexus Indiana to get involved.