L&T Technology Services

AUGMENTED AND VIRTUAL REALITY: A SAFE LANDING ON THE MANUFACTURING FLOOR?

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PERCEPTUAL
ENGINEERING

Table of Contents

REVOLUTIONIZING FACTORY VISIBILITY WITH AUGMENTED AND VIRTUAL REALITY

There is a deeper way to look at things beyond magnifying and microscopic lenses. On the factory floor, augmented reality (AR) and virtual reality (VR) empower manufacturers to gain insights into their equipment health and product models. This leads to operation and process efficiencies, which in turn enhance product quality and time to market.

While most smart manufacturing practices promote automation, AR and VR sharpen human capabilities. These technologies improve hardware visibility by leveraging sensors, cameras, smart devices and wearables, and other Industrial Internet of Things (IIoT) tools. Tasks such as training, assembly, and maintenance have accordingly become much easier. In the long run, upgraded AR and VR apps will also reduce the use of conventional manuals and hassles encountered due to poor version control.

By the close of 2017, AR/VR spending on on-site assembly and safety will stand at $362 million and process manufacturing training at $309 million. Four years on, spending will divert toward industrial maintenance, outweighing other segments, such as public infrastructure maintenance and retail showcasing.

TRANSLATING TRAINING EFFICIENCIES INTO MANUFACTURING GAINS

In pre-AR/VR times, building heavy equipment such as aircraft was not only labor- and time-intensive, but also entailed assembly training for years. Now, as each component is embedded with depth/motion sensors, and cameras, they can be viewed through an AR-equipped tablet or headset. The AR device displays an image of the components, overlaid with renderings of specifications, bolts, cables, parts, and part numbers, facilitating engineers to accurately assemble complex heavy machinery by simply following the instructions. In an aircraft manufacturing training facility, this technology enabled engineers to increase productivity by 30 percent and assemble the aircraft with 96 percent accuracy.

VR-simulated training programs help provide hands-on experience within an artificial setting, in which new employees can learn complex processes while immersing themselves in an animated three-dimensional replica of the actual facility. The methodology has yielded higher retention rates compared to lecture-style or reading-based methods. In a petroleum facility, training helicopter pilots to safely land on offshore oil platforms using VR simulation helped the company save $2 million in logistics. Its employees also retained 75 percent of the information disseminated during the training program.

There remains no doubt therefore that AR and VR can disrupt training methods used in the manufacturing industry, especially since the new generation of recruits are digital natives who communicate through voice or visual means 93 percent of the time. With US manufacturing companies facing a 300-hour labor shortage per year and expected to lose 2.7 million skilled workers due to retirement in the next decade, they will need to leverage AR and VR to keep their factories running.

RAISING THE IQ OF SMART PLANTS

When implemented across processes such as prototyping, development, construction, and assembly, AR and VR can help manufacturers maintain quality and safety standards. For instance, a leading ship-building firm leveraged these technologies for digital storyboarding, thereby reducing construction costs by 35 percent and inspection trimming from a 36-hour activity into a 90-minute one. This enabled the company to bridge the skills gap and address the impending exodus of manufacturing workers.

With smart AR/VR wearables becoming "ruggedized" to withstand hazardous conditions, the market for these products is projected to reach $55 billion by 2022. The easy availability of real-time information on manufacturing operations, digital drawings, and plans has prompted their accelerated adoption. A survey found that more than a third of manufacturers are already using these technologies or plan to do so in the next three years. For AR devices and content alone, revenues are, therefore, expected to rise 11-fold more than the earlier estimated $3.4 billion by 2019–reaching a staggering $36.4 billion by 2023.

AR/VR Applications on the Manufacturing Floor

Manufacturers can leverage AR/VR functionalities for multiple operational activities on the factory floor, including:

1. Design Improvement

AR and VR can smoothen the transition toward individualized and customer-centric production by catalyzing the product design improvement process. Coupled with model-based digital twinning and IIoT, AR's overlaying features and VR's auditive, visual, and haptic simulation capabilities enable product design engineers to generate, study, and test virtual prototypes. These design capabilities helped a packaging company to extract 30 percent more cooling capacity from one of its products.

The automotive industry is heavily investing in AR and VR to improve product design. VR-equipped 3D visualization software helps OEMs reduce prototyping cost as well as enhance the design review process and its feedback loop. This, in turn, shortens the product lifecycle (PLC) and accelerates time to market.

2. Complex Assembly

Besides aircraft assembly training, engineers can streamline customized product development in smart plants using AR-powered worker guidance systems. The system blends artificial intelligence and other detection components with high-lumen industrial strength projectors and torque guns to ensure that products

are built without errors the very first time. An automotive manufacturing major deployed a method known as "Light Guidance System" to error-proof its assembly operations, improving process quality by 80 percent and reducing overall process time by 38 percent.

In the aeronautics sector, AR-equipped smart glasses enable technicians to improve precision efficiency in assembling and installing cabins in commercial aircrafts. The head-mounted gear has a camera that can scan barcodes. Technicians use it to read cabin information and see the design layout, which displays the marks as "augmented" items. The marking process now becomes simpler and allows the technician to confirm the mark location and validate it with millimeter-precise positioning.

3. Quality Assurance

AR plays an integral role in enabling the quality control of manufactured or assembled products. The automotive and aerospace industries have already begun leveraging AR-equipped glasses and tablets to examine the quality of parts sent by third-party suppliers and placement of different components in the assembly line.

The worker guidance systems used for assembling components are also utilized to assure product quality. The AR-facilitated tool combines industrial cameras with high-powered projectors to display essential information directly onto the work surface. The resultant "digital canvas" allows technicians to verify and validate assembly sequence and manufacture parts "perfectly." OEMs and Tier 1 automotive manufacturing firms that have adopted "Light Guide Systems" over traditional work instructions have reported a 90 percent reduction in errors and 40-50 percent reduction in cycle time.

4. Maintenance

Industrial maintenance management is critical to ensure enterprise asset health and reduce downtime. Engineers implementing maintenance protocols for industrial equipment leverage AR-overlaid displays to view the machine's condition, facilitating problem detection ahead of solving it in person. In one instance, an AR-headset used a technology to guide a technician with instructions on the line of sight. This helped improve his performance in wiring a wind turbine's control box by 34 percent.

A recent innovation in AR-based maintenance software further allows technicians to track the position of the overlay so that content does not get dislodged when the user moves the tablet around.

5. Expert Support

Remote assistance using AR and VR solutions can enable people in different geographies to connect and troubleshoot problems together. A technical issue in the US can be resolved by collaborating with an engineer in China using IoT- and voice-enabled AR glasses, thus cutting travel costs and expediting the problem-solving process.

Additionally, AR with visual and haptic capabilities can be used to remotely operate tasks through robots in an uninhabitable environment. Such teleoperation systems enable engineers to immerse themselves in a VR interface and then control robotic motions, and on-site welding or parts assembly.

6. Safety

Monitoring hazardous conditions remotely using VR and deploying maintenance protocols using AR-powered tablets enable engineers to securely effectuate safety standards. A leading coal mining firm deployed an AR system for maintenance planning for long wall equipment, belt conveyors, and loaders. The system used 3D-simulated images to virtually recreate mining conditions and scenarios such as underground rock falls. It immerses users in the experience, thereby facilitating improved performance, health, and compliance to safety standards.

In another case, an automotive OEM leveraged virtual manufacturing technology to design a safe and efficient work environment. The immersive VR used, along with 3D printing and full-body motion capture, enabled reduction of employee injuries by 70 percent and ergonomic issues by 90 percent.

7. Warehouse Operations

Smart warehousing has disrupted distribution logistics practices by enhancing the precision and speed of fulfilling orders. It leverages AR to more efficiently "tag, code, and manage" freights. As sensors are now priced below $10 per unit and cellular ubiquity is expanding IoT opportunities, the freight handling process has become more systematic, allowing for accurate picking and packaging. Reports suggest that warehouse workers using AR have improved their picking accuracy by up to 300 percent and accelerated their performance by 30 percent.

RESHAPING MANUFACTURING'S FUTURE WITH CONVERGED TECHNOLOGIES

With the business community increasingly turning to AR and VR applications, new entrants are looking to capitalize on this opportunity. Currently, the count stands at 737 AR and 685 VR startup companies worldwide. The sale of VR headsets will nevertheless rise up to 500 million by 2025 and AR/VR revenues will expand by over 100 percent by 2021 globally.

Even though AR and VR have been around for over 50 years, many companies still remain greenhorns when it comes to utilizing them. Yet, the US Patent Office has until 2014 received 1,228 applications for AR-related patents with five key technology subjects (Figure 1).

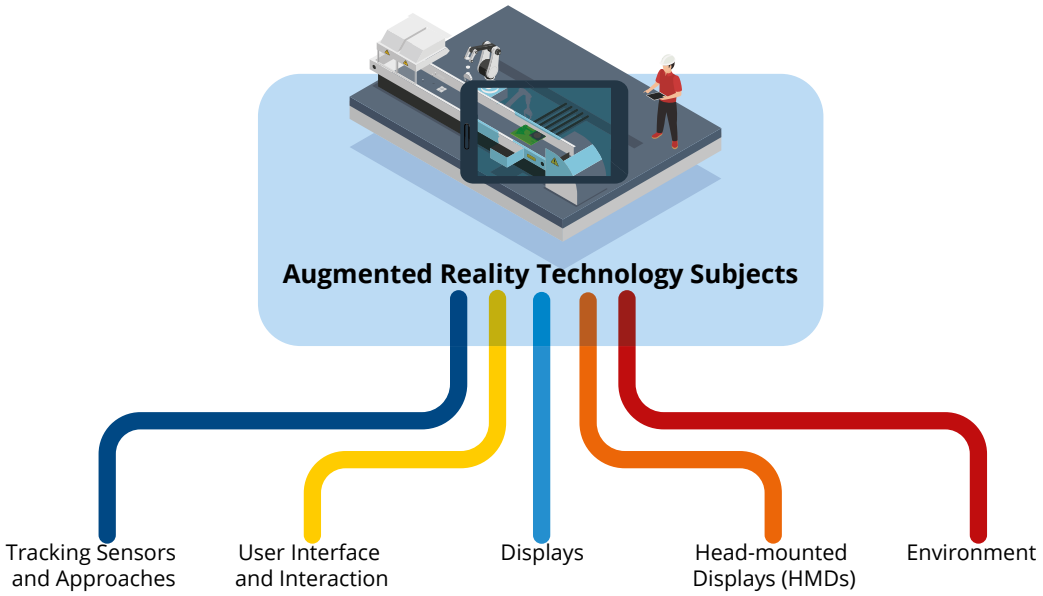

Figure 1: Augmented Reality Technology Subjects

Presently, AR and VR are being converged with IoT into mixed reality (MR) to provide a more seamless and realistic experience. R&D is also underway to miniaturize AR, VR, and MR devices, develop powering schemes for its extended use before the next recharge, and enhance the stretchability and flexibility of components to enable their usage in diverse environments like low or high temperatures and under oceans. With 5G mobile networks another two years away, organizations can expect to very soon reduce their mobile connectivity costs incurred to mass deploy AR and VR. A high-definition 360-degree VR experience with HMDs after all streams at a speed of 80 to 100Mbit/s, which means that unprecedented amounts of data are required to run AR and VR applications at high speed across the network. While device cost currently ranges from $100 and $3,000, the active innovation ecosystem will eventually help reduce device and technology costs, leading to mass adoption.

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