



Immersive Workflows

Report: The Use of AR & VR
in Manufacturing

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In conjunction with:

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1.0 Current Uses of VR & AR in Manufacturing

Here at VR Intelligence, we speak with companies across all industry sectors every day, about the growth of immersive manufacturing and how it's impacting the way they design and produce products.

What's very clear is that both virtual and augmented reality technologies have a significant place in the manufacturing cycle and are bringing real benefits to businesses on a whole host of levels. We've produced this short paper to look at where VR & AR are currently being used by manufacturers and the what the near future holds.

The first thing to note is that virtual reality in particular is nothing new to large-scale manufacturing. Early adopter companies such as Ford, Boeing and Lockheed Martin have been using the technology for decades. But with the relatively recent development of new, more affordable and better performing hardware and software, the pace of adoption across the manufacturing sector has increased rapidly.

Add to this the dawn of a suite of augmented reality devices and applications over the last few years and the scene has been set for a real revolution in immersive manufacturing.

So let's have a look at where the technologies are currently having an impact – and what the next phases of development, application and usage look likely to be.

Many manufacturers are now seeing the benefits both augmented and virtual reality can offer in an industrial environment. From design and visualization in pre-manufacture, right through to enhanced worker guidance and training during the production process, new and improved ways of using the technologies across business lines are constantly being piloted and deployed across enterprise.

“Collaboration
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most beneficial
thing that the
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and VR.”

Elizabeth Baron, Ford

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1.1 Design and Visualization

Both VR and AR bring incredible opportunities for product design teams to more accurately shape and test their designs before any physical materials are brought into the process. Gone is the need for clay models or other expensive prototypes – creating 3D assets in VR can deliver extremely accurate representations of real life products before a piece of metal is cut, a screw is tightened or a bolt is fixed.

In industries such as aerospace and automotive, as design reviews take place, the opportunity to test ergonomics and safety features is hugely improved with the use of virtual environments. Most of the leading OEMs now rely heavily on CAVEs to enable their design teams to continually test and adapt designs with incredible accuracy.

The immersive nature of CAVEs and the ability to create digital twins also allows for a much more collaborative approach to design, which delivers real benefits. As Elizabeth Baron, who leads Advanced Visualization and VR at Ford Motor Company said on a recent VR Intelligence webinar, “Collaboration is the single most beneficial thing that the executive leaders at Ford saw in the potential and promise of AR and VR. Globally connected collaborative working is what really sold the technology and has provided the biggest ROI in our company”.

“[AR] adds to the knowledge of the person working – whatever point they’re working at on [the] assembly line.”

Rich Rabbitz,
Lockheed Martin

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1.2 AR on the Assembly Line

Any product manufacturing involves putting together multiple components (often hundreds or thousands) in a precise sequence as quickly as possible. This is true whether you're manufacturing televisions or car engines, and every new product requires a new set of assembly instructions.

Emerging AR applications give new life to delivering real-time instructions to workers on the front line and can provide the opportunity for guidance on all tasks and overlay images to make assembly more accurate.

Using HMDs or glasses, instructions and support can be in a worker's field of view at all times; enabling hands-free operation and minimizing the need to check in at work stations, all of which increases productivity. As Rich Rabbitz from Lockheed Martin details later in this paper, AR "adds to the knowledge of the person working – whatever point they're working at on [the] assembly line. They have this added augmented data that they can use when they're doing their particular task. It's really proving to be critical to get performance from these people".

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1.3 New Workforce Recruitment, Training & Knowledge Retention

Because of the immersive and realistic nature of VR, it's very well placed to enable companies to create real life scenarios and situations that would either be impossible – or very costly – to replicate in real life.

In an industrial setting, GE is taking advantage of this. Speaking with the Wall Street Journal last year, Julie Grzeda, Director of Global Leadership Programs and University Relations at General Electric, revealed that GE has started using virtual reality to improve its employer brand and showcase its tech-forward positioning with millennials and other audiences. Potential candidates at college and recruiting events can use a VR headset to experience one of the company's new trains rushing across the plains or the technology behind its undersea oil and gas operations.

Once in place, AR and VR can speed the onboarding of new workers and improve worker productivity, by offering more immersive, on-the-job training. As we've already noted, glasses that project video, graphics and text can visually guide a worker through assembly or maintenance tasks.

Together with providing companies with an opportunity to showcase work to potential employees and on-board workers better, AR and VR also give them the opportunity to retain the knowledge of an aging workforce. No longer does an expert technician need to be in place to train and oversee every technician or machinist, companies can now use AR technology to supplement their employees' existing knowledge – potentially even with engineering expertise delivered via telepresence.

Put simply, with the right application of augmented reality on the production floor, training becomes truly "on the job". You can feed training information right on top of the actual parts and assemblies. So you can start mixing the actual delivery of tasks directly with training, which ultimately makes the equipment easier to learn and use.

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1.4 Ongoing Maintenance, Error Detection and Quality Assurance

Tied into training and operational usage of AR and VR is the opportunity to use it for ongoing maintenance and error detection. As Mark Sage from AREA details later in this paper, Newport News Shipbuilding reports a 96% saving in time on their inspections since they've started incorporating AR into the process.

Other examples include Thyssenkrupp, the elevator manufacturer who provide technicians with HoloLens technology as a tool in service operations. Using HoloLens, service technicians can visualize and identify problems with elevators ahead of a job, and have remote, hands-free access to technical and expert information when on site. This has reduced the average length of Thyssenkrupp's service calls by up to four times.

Also out in the field, GE Renewable Energy have a video on YouTube showing a worker completing wiring insertions for a wind turbine. The video compares the worker using paper instructions versus as AR headset and the technician sees an immediate 34.5% productivity improvement.

Back in manufacturing plants, the equipment, machinery and components all being used to manufacture products can also get a helping hand from augmented reality. Important maintenance procedures can be made much easier and more accurate meaning the status of equipment can also be assessed in far shorter timeframes – saving significant cost.

The monitoring of incoming component parts and outgoing products has traditionally been done by means of drawings or simple checklists, which require time and effort to compile. But with the new AR applications, preset CAD models can be accurately overlaid onto a real time video image. When placed over a physical component, this enables a direct comparison of the component with the plan or CAD data and any discrepancies can be recognized instantly.

In addition to the pure geometry of the part or assembly, the inspector can also have all other necessary information on the device, such as ISO standards, core data, metadata etc., so no other medium is needed for the inspection process. This all makes it possible to carry out incoming goods inspections more quickly and easily than ever before.

AR & VR in Manufacturing – A Summary

It's clear that both augmented and virtual reality technologies are vastly increasing productivity and efficiencies for manufacturing companies. The practical applications are there, and the benefits can be enormous. From reducing training costs and increasing knowledge retention, to getting products to market quicker or making assembly lines and maintenance tasks vastly more efficient; there are huge opportunities available for manufacturers to take advantage and they're only going to get even more pronounced as the technologies mature.

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"In design, everybody I've seen working in manufacturing is using augmented reality in some form."

2.0 Interview: Rich Rabbitz, Lockheed Martin

Rich Rabbitz is an engineer in Lockheed Martin's Rotary and Missions Systems business area. As the technology lead, his group is tasked with finding innovative ways to apply advanced visualization techniques.

How are you seeing AR and VR being used in design, engineering and manufacturing across industry? Which sectors are leading the way?

Today, as you may or may not know, you can actually watch an NBA game using a virtual reality headset. The NFL plans to do the same. You can also already virtually attend concerts in VR. This technology is based off 360-degree cameras.

A few months ago, I saw a surgeon at UCLA use collaborative VR to teach his attending residents and also to do pre-operative planning for brain surgery. The models are built using real scan data from MRIs to build a virtual brain of a particular patient. The surgeons could then see where vital parts could potentially be next to a tumour in order to have it surgically removed. You can look at the problem from different angles that wouldn't be possible with a flat scan image or during the surgery itself. A whole team of surgeons are able to have their own individual view, but then a leader is able to guide them to certain areas of particular interest.

In design, everybody I've seen working in manufacturing is using augmented reality in some form. They have this added augmented data that they can use when they're doing their particular task. It's really proving to be critical to get performance from these people. So, they're more productive, the quality is better, and it actually seems to be something that they are excited to do.

What are the biggest successes you've seen from companies using VR and AR to date? What have been the most transformative applications of the technologies you have seen so far?

The reason I like the surgery example is that you're getting a bunch of people to collaborate together. We can have more than one person in the virtual reality environment and go over critical design issues inside the virtual product.

That is something we are using extensively at Lockheed Martin. Within the last year it really has taken off. The technology has got to the point where we can use it to its fullest extent. We use VR in conceptual design, and it's really enlightening for our designers and customers to virtually walk through the entire facility, ship, plan or helicopter before it's even built.

VR is also very useful for ergonomics analysis, so different sized people can actually see what it's like to operate and maintain the entity we are going to build. Studies can be conducted in the areas of viewing, reaching, navigating and fitting into tight spaces.

We're also using VR to author our AR content. We register key points in VR, then when we go to the physical product we can register our AR with the same key points on the physical model. In the future we hope to use VR and AR for our customers to perform maintenance or even operations training.

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One thing I've seen that really impressed me is that they're actually using VR to train robots. As an example of that, you could train a robot to putt on a golf green. If you were using deep learning to do that, the first few times you put the robot out there it would probably rip the green apart. You can put that robot into virtual reality so that it still gets the same stimuli to its sensors, but without the risk to physical spaces. The same can be applied to an assembly line.

How do you think virtual and augmented reality will change how companies do business in the next five years? And what are the main barriers to mass enterprise adoption?

"In any industry where the equipment and products on which you're operating, and the procedures you have to perform are particularly complicated, virtual reality will be the place to train people."

In the next five years I really think VR and AR will explode in the entertainment and sports spaces. If you think of the currently untapped revenue you can generate through selling virtual tickets to sporting events or concerts to people who are far away from the event – the potential is huge. You can also provide a better experience – imagine standing on the goal line pylon during an NFL play-off game. I know I would buy that if it were available today. Similarly, if I could attend a concert in the UK with front row seats, all from the comfort of my home here in America, that could be really exciting.

If virtual reality is good enough to train neuro surgeons, it should be good enough for all kinds of training. I know a number of teams in the NFL is using VR to train quarterbacks in how to read defensive line outs. It gets the muscle memory going and improves the reaction time for the quarterback to take action depending on the movements of the defence on the other team.

In any industry where the equipment and products on which you're operating, and the procedures you have to perform are particularly complicated, virtual reality will be the place to train people. You can't really break anything in VR, so rehearsing in that space is really a great idea. Then when it comes to performing in the real world, you're going to see much better results.

AR and VR are going to be tightly integrated with the internet of things. We will have more and more products with sensors out in the market. You're going to need a way to visualise all of that data, and I believe dashboards in augmented reality are the answer to that problem. As an example, for the average naval ship you could have hundreds of sensors, and we'll need to be able to drill down to a particular cabinet, or even inside that cabinet to a particular circuit board to see what is happening, how to maintain it or how to fit it.

The technology is good enough with VR and AR so that we have a really great tool now. Engineers love it, and they really want to use the technology to see their designs long before the product is built. However, we need to remember that both VR and AR have been cyclical, and there are a few people even today who have been put off by bad experiences with previous iterations of the tech. This is the culture we need to get through today – making people understand that this is a really good engineering tool, and not just some gimmick.

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3.0 Interview: Mark Sage, AREA

Mark Sage is the Executive Director for AR for Enterprise Alliance (AREA), a global, non-profit, membership-funded alliance that focuses on the adoption of AR in the enterprise.

How are you seeing AR being used in design, engineering and manufacturing across industry? Which sectors are leading the way?

At the AREA, we’re seeing the earliest AR deployments in areas where organizations can reap a tangible return on investment. Whether you’re looking at manufacturing, aerospace, automotive or construction, they’re all investing where the savings are greatest.

For example, there’s a company that’s using AR to help build satellites. These satellites are large and cost billions. What used to happen was that workers would scale some scaffolding to install a component part, then someone else would have to go back up to ensure it was done properly. With AR, they can use a wearable to record what has been done. The supervisor can then remotely view the work and tick it off. They’re saving almost 50% of the time and effort.

Another simple use case involves maintenance issues. Workers can be helped remotely as they go through a repair with step-by-step instruction. It’s relatively easy to show an ROI in terms of savings once AR and similar technologies have been adopted.

Our membership is strong in aerospace, manufacturing, and automotive – but we’re finding that AR is not focused to one industry. It’s more to do with the use case and if that’s relevant to your particular industry. AR is so transferable from industry to industry that it’s really about what problems you can solve using the technology.

What are the biggest successes you’ve seen from companies using AR to date? What have been the most transformative applications of the technologies you’ve seen so far?

There’s an excellent [report published](#) by *Harvard Business Review*. They went through different industries – some of which can be found within our membership – and they highlighted some of the savings those companies have made.

One great example is Newport News Shipbuilding, which builds aircraft carriers. It takes them seven years to build one aircraft carrier. When they did an inspection after the work had been done, it used to take them 36 hours. Using AR, they have taken that down to less than 90 minutes. That’s a 96% saving in time. When you extrapolate that over a seven-year period, it’s a phenomenal saving.

The remote assistance piece is also significant. Companies are using AR instead of having to fly people all around the world to do a task. Instead, local workers can talk to experts immediately using AR.

In terms of transformation, what we’re seeing is a revolution more than evolution. The early adopters we’re seeing includes anything that allows workers to continue doing their task without having to break away to look at a laptop or a tablet for diagrams, further instruction, and things like that. For the most part this involves taking the tasks being performed already, and just making the processes that much easier.

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“There are some challenges generally for enterprises around the digitization of organizations. AR really only works when you have digital content and that content is in a format that can be used in AR.”

For example, Boeing has recently completed an AR project on the installation of aircraft wiring harnesses. It's incredibly complicated work. They're using Microsoft's HoloLens to put all of that wiring harness information into an augmented reality view. You can then look at individual sections of the wiring in tremendous detail or in isolation, troubleshoot potential issues before they arise, and highlight issues such as access for engineers. This helps improve efficiency massively, but also boosts training capacity because they can have new employees view HoloLens material to quickly get up to speed. That becomes even more of an imperative for companies like Boeing, as a proportion of their workforce are coming to retirement age.

How do you think virtual and augmented reality will change how companies do business in the next five years? And what are the main barriers to mass enterprise adoption?

In the near future, the wearable devices themselves need to improve. Everything we've seen from the past shows that the technology will improve. These devices need to become much more safe and secure. They need to be usable in what can be quite difficult environments, whether they're dirty, dark or even a giant Faraday cage. Luckily, an AR device can actually help you understand some of those safety issues.

There are some challenges generally for enterprises around the digitisation of organisations. AR really only works when you have digital content and that content is in a format that can be used in AR.

I recently visited a company that still uses paper and rubber stamps to check off work. There needs to be a shift to digitisation, and those companies need to understand the benefit of the digital twin. This barrier is more than just an AR issue. It's something much more fundamental about the future of business and industry.

Another barrier to adoption is making sure that staff are involved in the development and decision making process. We have a number of change management stories that focus on the best ways to encourage people to use this technology. Some people are apprehensive about new technology, especially if they have been working in the same way for a long period of time.

The final piece is around general awareness, and that's an area where we have been doing a lot of work at the AREA. As we do more work within the ecosystem, organisations have a broad range of technologies they could potentially use – including AR, IoT, digital twin, the list goes on. Organisations need to understand the benefits of AR, and how it's really part of a wider digitisation strategy.

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Immersive Workflows: AR & VR in Manufacturing (VR) Intelligence



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With so much opportunity on the horizon for VR & AR technologies to be used across manufacturing and enterprise as a whole, now is the time you need to hear from those leading the charge across industry and network with the true pioneers in the field.

VRX: Immersive Enterprise 2018 (June 26-27, Boston) is purpose built to give you the chance to do just this: www.vr-intelligence.com/enterprise

The high-level conference and exhibition is the leading senior-level B2B event for executives from across industry looking at the business applications for immersive technology. Bringing together **global business leaders from AEC, Automotive, Manufacturing, Engineering, Retail, Energy, Healthcare and more**, the event is purpose built for VR/AR professionals to network and share industry insights on how to drive enterprise transformation with virtual & augmented reality.

With leaders from the most pioneering enterprises and tech companies, you'll identify where VR & AR content and technology are having a real impact on training, design, worker collaboration and sales & marketing. Plus you'll get the latest market insights from top analysts and investors on where the opportunities are now...and what's coming next. With senior speakers from many of the globe's biggest companies and tech juggernauts, the agenda features senior business leaders from **GM, Lockheed Martin, Ford, Lowe's, Gensler, HTC Vive, Johnson & Johnson, Skanska, Wayfair, Oculus, Cadillac, Jacobs, Gulfstream Aerospace** and dozens more. So if you're looking to explore how virtual and augmented reality is transforming enterprise, there's no better place for you to learn from and network with the top tier companies leading the charge.

Head to the dedicated event website to see more: www.vr-intelligence.com/enterprise and if you're looking to attend, quote **WP4976** when you register to get an extra \$100 discount on the current listed rates.

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➤ PROVEN CASE STUDIES SHOWCASING REAL RESULTS:

Find out how to capitalize on right opportunities as business awareness of the wide applications of VR & AR increases

➤ AR, VR - OR BOTH? Learn which is right for which applications - and how to make sure you don't waste time and money finding out

➤ PICKING THE RIGHT USE-CASES: Understand which

technologies and platforms suit which purposes. And how to make sure you always pick the right applications for your business

➤ TOOLS, APPLICATIONS & IMPLEMENTATION:

Understand the tools available, best use-cases and methods of implementation for VR & AR across different industries

➤ SCALING UP FOR SUCCESS: Overcome the challenges of scaling

XR in your business. Find out how to drive projects from the lab to full-scale deployment

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