

***For US manufacturing,
virtual reality is for real***

How virtual and augmented reality technologies
are reimagining America's factory floors

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As virtual and augmented reality technologies come of age, manufacturers are finding ways to adopt these technologies on a number of fronts—from product development, to training, to maintenance and repair, to worker safety. And, in the wake of hefty investments in the technology over last couple of years, a new generation of virtual reality (VR) and augmented reality (AR) devices and software is becoming available.¹ If the technologies catch on, as many believe, millions of us will be crossing into new realities soon. Combined VR and AR sales is forecast to hit \$150 billion by 2020, according to one estimate—with AR alone comprising about \$120 billion.²

But how will this technology change US manufacturing? As part of PwC's ongoing "Next Manufacturing" series of research exploring disruptive advanced manufacturing technology, we look at how VR and AR are changing the landscape of America's factory floors. To do this, we surveyed 120 US manufacturers in our 2015 PwC Disruptive Manufacturing Innovations Survey. The results reveal a snapshot of how these technological tools are being used by manufacturers and suggest how their adoption could change in the future.

1. Note: Please note that the two technologies we cover in this survey are defined as: VR, requiring headsets, create a fully immersive virtual experience, while AR is quasi-virtual experience in which a layer of data, images and communications augments the actual world, best produced with smartglasses.

2. "Report: Virtual Reality rules now, but augmented reality will soon take over", www.networkworld.com Nov. 4, 2015.

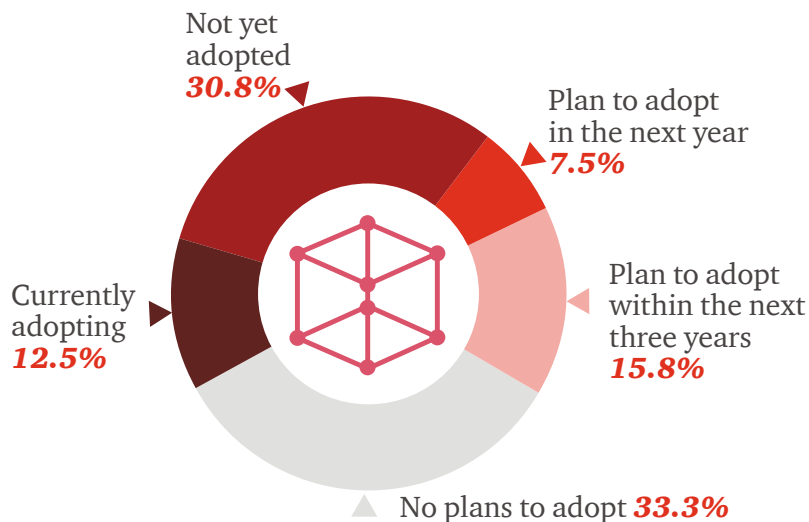
Key findings:

VR/AR on path of mainstreamed adoption

According to our survey, an impressive adoption of the technology is already afoot. More than one-third of US manufacturers we surveyed either already use VR technology or plan to do so in the next three years, with adoption plans for AR technology roughly the same. Meanwhile, another one-third of manufacturers have no plans in place to adopt the technologies. Of course, adoption could run the gamut—from experiments or trialing the technology, to more ubiquitous or more widespread use among workers for whom it makes sense. Clearly, users of VR and AR technology have been using “legacy” devices such as computers, smartphones and tablets for some time and may well continue to do so, as new technology comes on line, such as less expensive and more advanced wearable technology including smart glasses, smart watches and headsets equipped with wider and more “realistic” sensory experiences.

More than one in three manufacturers expect to adopt VR and AR technologies by 2018

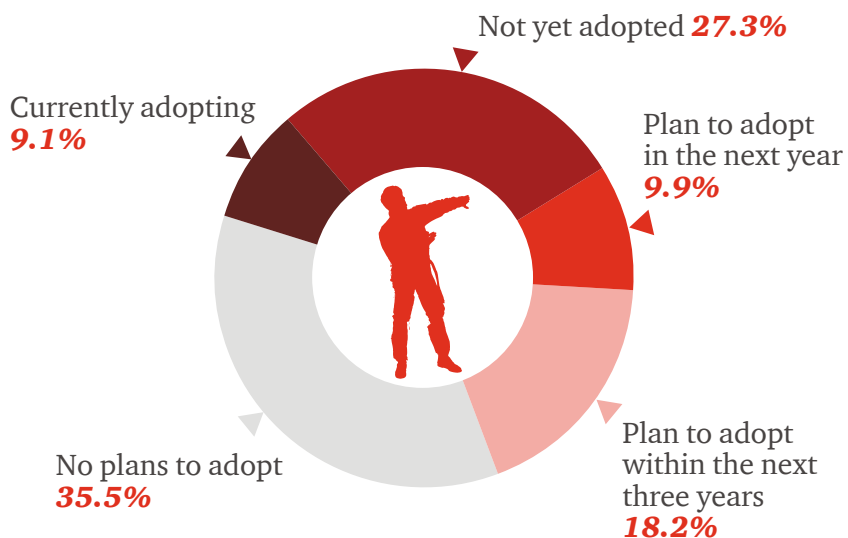
Q. How would you characterize your company's use of any type of virtual reality technology (e.g., fully immersive experience such as a CAVE system)?



Number of respondents: 120

Source: PwC and Zpryme survey and analysis, “2015 Disruptive Manufacturing Innovations Survey,” conducted in November 2015

Q. How would you characterize your company's adoption of augmented reality technology?



Number of respondents: 121

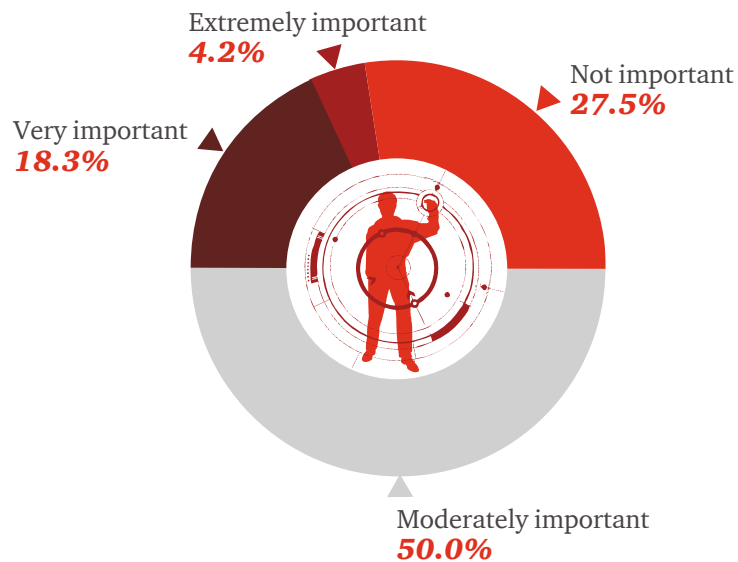
Source: PwC and Zpryme survey and analysis, “2015 Disruptive Manufacturing Innovations Survey,” conducted in November 2015

New visions for competitiveness

As the technology begins to be adopted globally and continues to demonstrate improvements in productivity, product development and even supply-chain advancements, for example, US manufacturers will likely see the need to adopt these technologies more aggressively to compete—our survey suggests. Looking ahead, nearly three of four respondents believe that VR will be at least moderately important to US manufacturing competitiveness.

VR/AR seen as important to US manufacturers' future competitiveness

Q. In the next three years, how important will virtual reality be to US manufacturing competitiveness?



Number of respondents: 120

Source: PwC and Zpryme survey and analysis, "2015 Disruptive Manufacturing Innovations Survey," conducted in November 2015

Product design most common application for VR/AR

How are manufacturers using VR/AR? Pretty much any way they can. According to our survey, the most popular application of AR and AR was product design and development (38%), followed by safety and manufacturing skills training (28%), maintenance, repair or equipment operations (19%) and remote collaboration (19%). [Note that respondents could choose multiple answers.].

What we're seeing, then, is VR/AR as an advanced manufacturing technology tool—just like robotics, 3D printing, and the Internet of Things. And they're being used in innovative ways. Some companies are fitting warehouse workers with smartglasses which read barcodes on containers of supplies inventory boxes and provide details contents and destination/origin information. Others are using it them for remote maintenance: picture a field technician that relays a live image of a part that needs to be fixed and a remote colleague supplies relevant data, instructions or images that could serve as a virtual repair manual. Or, smartglasses that help track complicated assembly processes to ensure that all parts are assembled in the right sequence without the down-time of consulting a clipboard, manual or even tablet. To take yet another example: parts inspectors can take a photo of a part that needs to be modified, and also add a spoken record of the issue and relay those data to the appropriate co-worker in seconds.

Product design, worker safety and training are most popular VR/AR applications among manufacturers

Q. How is your company using virtual and/or augmented reality technology? Please select all that apply



Number of respondents: 98

Source: PwC and Zpryme survey and analysis, "2015 Disruptive Manufacturing Innovations Survey," conducted in November 2015

In these instances, AR not only gets things done faster and better—but more efficiently. Hands-free, workers who might previously need to consult another device or manual or hand-held scanner, for example, now access data with the tilt of the head, a spoken command or a simple touch—all shaving seconds or even minutes off tasks frequently carried out. Saving a minute or two here or there may seem like a tiny productivity advancements, but it certainly adds up when an organization has thousands of workers carrying out, say, hundreds of routines daily.

Other applications, too, are taking hold, such as virtual assembly and improved process design, which 17% of manufacturers who are

using VR are using. Consider some manufacturers which create avatars—digital representations of factory-floor workers—to test what changes to a facility are needed to reduce strain on employees' backs during assembly. Or, using VR to create virtual prototypes of, say an engine or car interior, which designers and engineers and actually walk around and experience—cutting the considerable time and expense required by physical models. Taken a step further, virtualizing products before even a physical prototype is created enables manufacturers to share the product in the testing phase with customers, thereby creating a potentially better collaborative relationship.

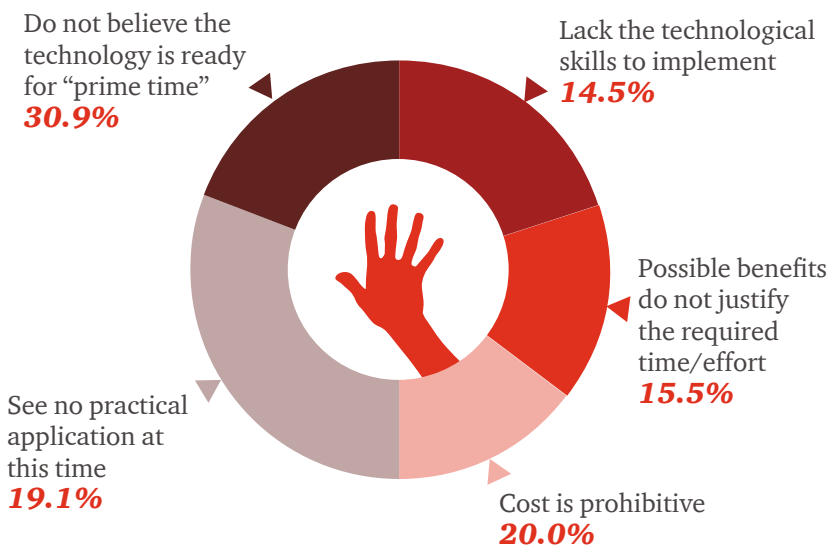
And for more dangerous jobs in industrial settings, intelligence has been added to the old hard hat. 4D “Smart helmets” are equipped with sensors, including thermal vision camera and a headband that measures the wearer’s body temperature, heart rate and even brain waves to monitor workers in dangerous situations or environments and how they may be reacting.

The VR/AR fence-sitters

Meanwhile, what’s holding back some manufacturers from jumping into the VR/AR world? According to our survey, about one-third of respondents not adopting say they are sitting on the fence because they have “yet to identify a practical application”, followed by those who cite prohibitive costs (20%) and another 31% who believe the technology is not “ready for prime time”.

Cost and perceived lack of need are top reasons for manufacturers not using VR/AR

Q. If your company has not yet adopted virtual and/or augmented reality technology, what is the main reason? Please select one.



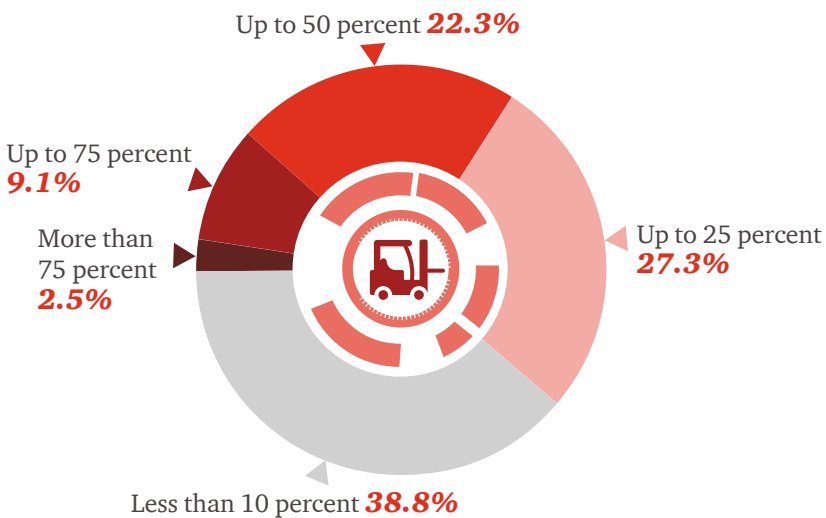
Number of respondents: 110
Source: PwC and Zpryme survey and analysis, “2015 Disruptive Manufacturing Innovations Survey,” conducted in November 2015

What's next?

While (as mentioned earlier) about one-third of manufacturers are using or plan on using VR/AR in the next three years, nearly 90% of those same manufacturers believe that no more than half of all manufacturers in the US will be using AR/VR technology over the next decade--and over one-third believe less than 10% will. At the surface this seems puzzling. But maybe what this is telling us is that adopters of VR/AR may believe they are higher up on the tech adoption curve than their peers. In any case, as the technology improves and price points lower for headsets and smartglasses, we expect manufacturers to keep finding creative applications to improve productivity, efficiency and, most important, worker safety.

90% manufacturers surveyed believe no more than half of US manufacturers will use AR/VR technology over next decade

Q. What percentage of US manufacturers do you believe will be using virtual and/or augmented reality technology ten years from now?



Number of respondents: 121

Source: PwC and Zpryme survey and analysis, "2015 Disruptive Manufacturing Innovations Survey," conducted in November 2015

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**To have deeper conversations
about how this subject may affect
your business, please contact:**

Robert McCutcheon

Partner

US Industrial Products Leader

+1 (412) 355 2935

robert.w.mccutcheon@pwc.com

Robert Pethick

US Industrial Products Advisory
Leader

+1 (313) 394 3016

bob.pethick@pwc.com

Bobby Bono

US Industrial Manufacturing Leader

+1 (704) 350 7993

robert.w.mccutcheon@pwc.com

From the Manufacturing Institute

Jennifer McNelly

President

+1 (202) 637 3426

jmcnelly@nam.org

Gardner Carrick

Vice President, Strategic Initiatives

+1 (202) 637 3491

gcarrick@nam.org

From the Manufacturing Institute

Chris Sulavik

Senior Research Fellow

PwC US Thought Leadership Institute

Thomas Waller

Director, US Industrial Products