

Wearable technology can be useful—if it's used right



What to Wear

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Jon Reneberg has such a passion for technologies that integrate with human interaction that he decided to be about as integrated as one can be with technology: He has two radio frequency identification (RFID) chip implants. One is in his right hand, which he uses to start his car. In his left hand he has a two-factor chip authentication on websites that use VivoKey and require his phone to scan the chip. “I am a technology nerd from end to end,” Reneberg quips.

As lead digital manufacturing specialist, Reneberg spearheads the Innovation and Technology practice at Purdue University’s Manufacturing Extension Partnership, and he has more than two decades of experience in manufacturing. While Reneberg admits his chip implants are “on the extreme end of things,” he says there are benefits in the far-less-extreme technology that is not implanted but rather worn for health, safety, training, efficiency and environmental reasons.

Whether it’s augmented-reality (AR) glasses that can overlay real-time information in a production process, exosuits that help prevent injury and reduce fatigue or sensors that monitor how employees are interacting with their environment, wearable products need to make sense and be properly used.

Safety is an obvious reason manufacturers may choose to deploy certain wearable tech. In 2022, the warehousing, manufacturing and construction industries experienced more than 700,000 non-fatal injuries and more than 2,000 fatal accidents. The U.S. Government Accountability Office says wearable tech could have the potential to improve safety in these sectors, but also says that more data is needed to show how effective the technologies can be.

Reneberg and subject matter experts caution that manufacturers



MakuSafe's wearable devices can measure air quality, heat exposure, strain or exertion concerns, slips and falls, and other critical data points. (Provided by MakuSafe)



need to properly communicate with employees the purpose and function of wearables, and they need to be rolled out correctly. “Culturally, you have to prove that there’s a benefit to the employee,” Reneberg says. “And just saying so doesn’t prove anything.”

Different wearable items have different places and purposes. Would it be reasonable for manufacturers to equip their workers with accessories from head to toe? Probably not. Let’s breakdown some of the more popularly used technologies and how they could benefit manufacturers and their personnel.

Extending Reality



The concept for HeroWear’s exosuits was born in Vanderbilt University’s Center for Rehabilitation Engineering and Assistive Technology lab. (Provided by HeroWear)

Extending reality with wearable glasses or headsets can be beneficial, if done properly. Among extended reality (XR) devices, AR currently makes the most sense for the factory floor while virtual reality (VR) is effective for training purposes.

In 2022, Tooling U-SME launched Virtual Labs, a learning and training program that uses an Oculus-based VR headset. The program first educates on basic skills, using e-learning, then sends trainees into a virtual environment to practice those skills. Training can involve going into a meeting with a virtual supervisor, who then gives a real-world manufacturing problem. Then, virtually, the attendee goes into a manufacturing setting to apply learnings. This kind of immersive experience has made training a more fun and engaging experience, says Chad Schron, senior

director for Tooling U-SME.

But most VR technology solutions are considered by Schron, as well as some tech companies and manufacturers, to be too dangerous to be deployed to workers on the factory floor, at least in places that require movement. Mixed reality (MR), too, in which there is a pass-through camera with overlaid imagery is likely too much of a safety risk for factory floors.

One MR solution is promising on the shop floor.

“The HoloLens 2 is the only one that’s got all the requirements for the factory floor,” says Scope AR CEO Scott Montgomerie, referencing Microsoft’s headset that, unlike its predecessor, does not require a tether. “So you can’t have a tether, you can’t have a cable, because that could get caught in equipment.”

Scope AR’s WorkLink platform for devices such as the HoloLens 2 allows users to view superimposed work instructions or 3D designs such as CAD files on real-world objects. The technology has found a footing in the aerospace and defense sector. Lockheed Martin, which has been a customer of Scope AR for several years, used the company’s technology to help build a space shuttle for NASA. And Northrop Grumman uses Scope AR to help build F-35 jets.

“One of the huge benefits of this technology is it’s showing you what you need to do so the potential for error is very low,” Montgomerie says. An example of it in use could be as simple as animations showing a step-by-step guide for how to assemble something—putting screws in specific areas, for example.

The old way of doing things, or those before AR headsets could be used, typically included a large paper manual that would have to be consulted in one area of the factory floor, and then by the time workers would get back to their stations they may not properly recall everything, Montgomerie says. “So with this mechanism of information delivery, you’re only showing what the manufacturing engineer wants you to see right now, and it’s perfect. It’s got all the information you want and only the information you want,” he says. “And so that means the cognitive load on the worker is actually substantially less.”

Still, there have been several barriers to adoption of XR technologies. The devices have had to be good enough, and Montgomerie says the HoloLens has filled that need. There also has to be buy-in from the

C-suite and companies' budgeting. And then content creation was also an issue, which is where Scope AR comes in.

The final issue, and perhaps the hardest, Montgomerie says, has been getting buy-in from the workforce. "We're talking about change management here, we're talking about people that just want to go and do their jobs, and are not really interested in adopting new technology." However, there has been a shift in this attitude with a younger workforce that is more open to trying this kind of tech, he says, and such tech has been effectively used as a recruiting tool. "Some of our customers are actual-



HeroWear's commercially available exosuit is the Apex 2, which uses elastic bands to help offload strain on the wearer's body. (Provided by HeroWear)



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ly using it as a competitive advantage,” Montgomerie adds.

Exoskeletons in the Closet

That same kind of workforce buy-in is needed for exosuits and exoskeletons, which can be worn to prevent injury and fatigue. There are two different ways of getting power to exosuits and exoskeletons: motors with batteries, which are typically called powered or active suits; or assistance from different kinds of springs, which are usually referred to as passive exosuits.

These kinds of wearables should not just be bought, thrown on the shop floor and left for workers to try to outfit themselves. There needs to be an organized deployment, says Paul Nicholson, HeroWear’s vice president of growth. “We have been brought in many, many times where customers say, ‘Hey, we tried one of your competitor products, and see: they’re all sitting in a pile over there in the corner gathering dust,’” Nicholson says.

It’s why HeroWear sends in a client services team along with its commercial product, the Apex 2, to train and oversee change management. “The exosuits can help you all day long in a lab, but if it’s not functionally usable by the user—gets in the way, things like that—it’s not going to succeed,” Nicholson says. “But also, if the change management isn’t handled well, it’s not going to succeed.”

The concept for HeroWear’s exosuits started in the mid-2010s as a project at Vanderbilt University’s Center for Rehabilitation Engineering and Assistive

Technology lab. One of the lab’s directors, HeroWear co-founder Karl Zelik, had young children who were taking a toll on him physically. He challenged students at the lab to build him something to help his back that was “invisible,” Nicholson says.

The result is a textile-based exosuit, the latest iteration of which is the Apex 2, launched last year. The Apex 2 has a switch on the shoulder that is controlled by a cable, and there are no motors or batteries. Once the switch is flipped, it engages elastic bands which, when the wearer bends over, stretch and offload part of the work.

“So whether I’m bending, squatting, lifting, leaning over a table, things like that, these bands are offloading 20 to 40% of the back muscle strain, which leads to up to 40% reduction in fatigue of those back muscles, which reduces the risk of injury very dramatically,” Nicholson says, adding that the suit does not do “all the work for the user, so you don’t get muscle atrophy.”

When the system is turned off, the wearer can move about normally and without the system engaging. It has adjustable shoulder straps, elastic support bands and thigh sleeves that are snapped together, thus customizing the fit for users.

Overexertion is cited as the number one nonfatal injury or illness involving days away from work in 2021-2022, according to the National Safety Council. And Liberty Mutual, in its 2024 Workplace Safety Index, estimated the cost of overexertion involving outside sources at \$12.49 billion per year in medical and lost-wage payments. So, solving the overexertion issue could also reduce lost productivity, companies such as HeroWear argue.

Preventing injuries and fatigue is at the core of SUITX exosuits, asserts Samuel Reimer, the company’s managing director for North America. SUITX was spun out of the Robotics and Human Engineering Lab at the University of California, Berkeley, which specializes in the research and development of occupational and medical exoskeletons, and then later bought by Ottobock of Germany. SUITX counts major manufacturers such as Mazda, Toyota, Boeing and Airbus among its customers.

The company’s IX Shoulder Air and IX Back Air suits use built-in spring mechanisms that help relieve stress on the shoulders and the back. With an adjustable setting, the IX Shoulder Air device can give the wearer’s arms the feeling of zero gravity. “It feels like swimming



MakuSafe customers use wall-mounted kiosks, which serve as charging and storage stations for sensor devices deployed to workers each day. (Provided by MakuSafe)

a little bit,” Reimer says. “If I have to do assembly line work, as it is very often the case in the auto industry, or even in the aviation industry, a lot of riveting welding tasks overhead, I can just completely relax my shoulders and do this all day long.”

The IX Back Air relieves the back in a way akin to when someone rests with their hands on their knees. When doing manual labor with the exosuit activated, Reimer says, “I don’t feel anything on my back, so it’s greatly reducing my likelihood of injury on my lower back, and increasing my stamina over the day as well, because I just don’t get as fatigued so easily, so there’s a little productivity boost to it.”

Like HeroWear, SUITX goes to sites and trains workforces on how to properly deploy and use their products.

Sensor Sensibility

While exoskeletons help prevent strain, ergonomic and environmental sensors can detect a host of factors impact-

ing workers. MakuSafe’s wearable devices can measure air quality, heat exposure, noise levels, strain or exertion concerns, slips and falls, and other critical data points. An analytics platform accompanies the devices and includes a dashboard of real-time information for factory managers to monitor. But while worker environment and safety can be overseen, MakuSafe stresses that it is not tracking workers. “There’s nothing personal, nothing biometric, no feedback delivered to the worker,” stresses Tom West, the company’s vice president. “We’re not constantly annoying them, and we’re not continuously tracking people.”

MakuSafe typically uses wall-mounted kiosks that serve as charging stations and house devices before and after shifts. The kiosks are typically placed at different entry and exit points to a facility. The wearable device itself is small and can be worn on a holster or an armband.

Once it’s checked out of the kiosk, the MakuSafe device starts generating real-time data and process-

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ing analytics which, within seconds, shows up on dashboards for leadership. “We’ve had clients that have really taken action based on that data,” West says, adding that “with a workforce wearing sensors and moving throughout a facility over time, a heat map results showing hazards, trends and patterns they didn’t know existed. Heat, noise, air quality, or slips and trips, for example.”

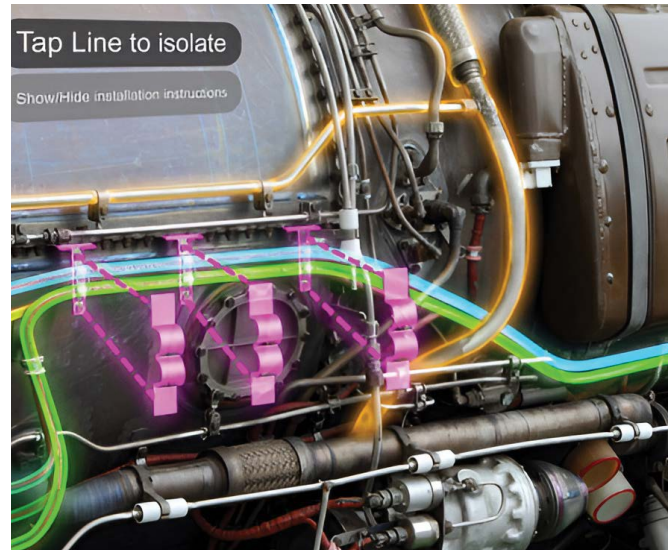
Data generated by the MakuSafe devices can also show that there’s been a lot of slips and trips in an area. It could reveal that the lighting is low in another area, and then management could determine that half the lightbulbs in that department have been out for months. The devices and their corresponding data also have the ability to show someone’s “aggregated physicality,” or the amount of effort that person has expended to do work over time, West says.

“We’ve had some dramatic results,” West explains. “I mean, organizations that reduce strain and exertion, injuries and incidents by 76% in less than 12 months. Organizations that have worked with us, with their worker’s comp insurer in the loop, and found half a million dollars in savings of those types in less than a year.”

Industry 4.0

The sensor and data can also be tied to Industry 4.0 and the notion of the connected factory, West says. Together, the data can show how workers are interacting with machines on the factory floor. “Our journey started as a safety technology, but we’re swiftly realizing that our clients are really helping us understand their challenges, so that we’re now completely understanding the connected worker and how the worker is integrated into an automated environment in a smart factory,” he says. “Data that’s being gathered really can be hugely beneficial.”

Reneberg, who in addition to tech is also a fan of industrial hygiene, sees benefits in MakuSafe’s sensors, as well as the products from the other wearable tech firms, seeing them as having positive ROI. But he stresses that they must be properly rolled out. Part of that could be a matter of timing. “Most manufacturing is cyclical or has



Scope AR’s WorkLink platform can overlay 3D instructions on a wearable augmented reality headset such as the Microsoft HoloLens 2. (Provided by Scope AR)

peak periods and off periods,” he says. “I highly recommend anything where there might be a discomfort to the employee, implement that then, not during your peak times.” Some things, like AR headsets or exoskeletons, could be rolled out at any time as some workers could find the tech immediately useful, he adds.

Reneberg says companies should be patient with any change. “Often, the bigger the company, the more likely they are to try something out and 30 days later say, ‘Well, the employees rejected it, let’s scrap that and move on to the next big thing,’” he says. “But what I would say is take your time with things like that.”

He also emphasizes the need for management to be open and honest with employees about any new wearable technology’s purpose. “And I mean fully honest,” he says. “So don’t just tell them what you think they want to hear, but be honest and be respectful of people’s privacy.”

For management, Reneberg adds: “Don’t be afraid to be the first person in the production floor using it. Don’t be afraid to put on a pair of gloves, go get your jeans dirty and test it out live.” 📶

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