



## Transforming Frontline Operations with Augmented Reality Technology

**The Industrial Workforce of the Future** is already here, driven by several macro trends that have produced critical industry-wide talent and skills shortages. Remaining competitive in this environment requires companies to re-imagine how they hire, train, and retain employees as they undertake Industrial Transformation (IX) initiatives. The frontline workforce plays an increasingly central role in the success of these strategic programs. The fast pace of change in smart, connected operations requires an unprecedented level of organizational agility to continuously field a workforce with the right competency profile.

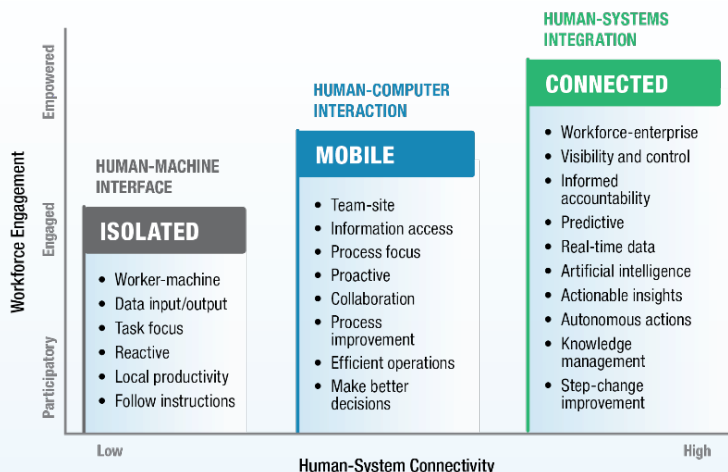
In response, many industrial organizations are incorporating Connected Worker initiatives into their overall digital transformation programs. These initiatives leverage both proven and emerging digital technologies such as mobile devices, robotics, augmented reality, sensor-equipped wearables, and IIoT systems. These and other technologies serve to better connect frontline workers with their work environment, facilitating the multidirectional flow of data, information, insights and actions to improve processes and overall operational performance.

Connected Worker technologies play a key role in enabling the Industrial Workforce of the Future by augmenting human capabilities. The goal is a frontline workforce that's more engaged, proactive and empowered with data-driven insights to make faster, better decisions. Our research shows that companies that have been most successful with their IX programs have adopted Connected Worker technologies more than others that are less successful. This report will focus on one such technology, Augmented Reality (AR), which has proven to deliver value by helping industrial organizations improve productivity, quality, and safety in frontline operations.

The goal is a frontline workforce that's more engaged, proactive and empowered with data-driven insights to make faster, better decisions.

**Peter Bussey**  
Principal Analyst

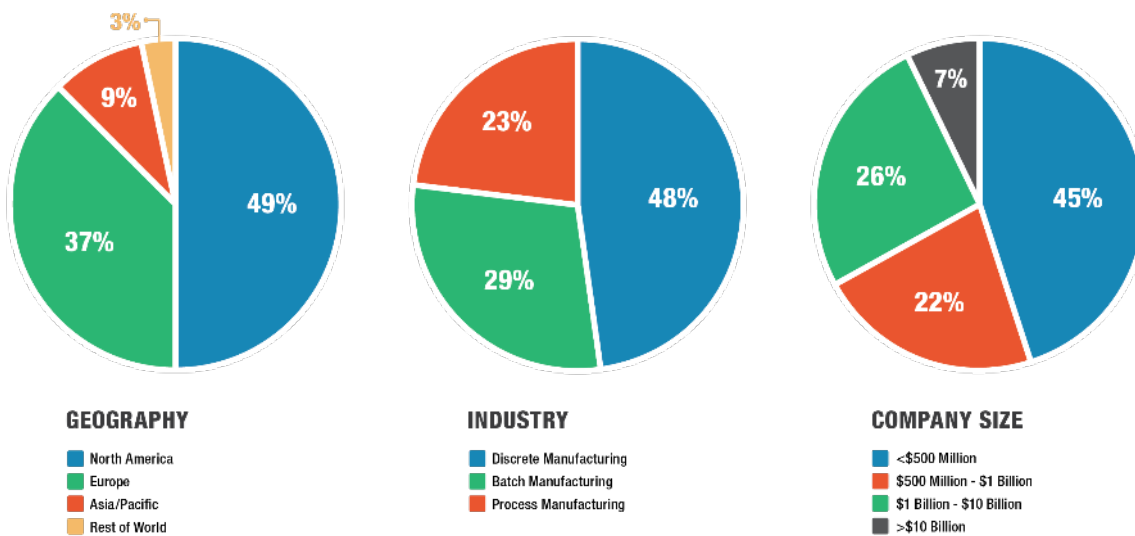
Evolution of Frontline Connectivity and Workforce Engagement



©LNS Research. All Rights Reserved.

## Research Survey Demographics

The main source of the research data presented in this report is a global survey executed by LNS Research in 2019 on the topic of “Industrial Transformation Technology and Use Cases.” We obtained valid survey responses from 275 executives, management, and operations personnel in industrial organizations. The respondent pool was well-diversified by geographic region, industry, and company size. Nearly half of the respondents were in North America, and over a third were in Europe. The survey gathered data on the status of Industrial Transformation programs including strategic initiatives, deployment of enabling digital technologies, and use case implementation.



©LNS Research. All Rights Reserved.

## Connecting Frontline Workers Across the Value Chain

Connected Worker technologies can deliver value throughout operations and across entire the value chain. LNS Research defines the Connected Worker scope to potentially include all front-line workers involved in production of goods or delivery of services whether they are working in the plant, at a remote facility, at a customer site, in transit, or some other location.

IX initiatives optimize end-to-end processes by holistic implementation of people, process, and technology capabilities. Connected Worker opportunities exist across these “digital threads” encompassing core value chain functions such as operations, maintenance, and field service, as well as support functions such as EHS and Quality. Similarly, the range of Connected Worker use case opportunities spans the entire operational management system, with the potential to drive diverse benefits by fundamentally changing how workers interact with and engage in the work environment.

The range of Connected Worker use case opportunities spans the entire operational management system, with the potential to drive the diverse benefits by fundamentally changing how workers interact with and engage in the work environment.

**Peter Bussey**  
Principal Analyst

### Connected Worker: Operations-Wide Scope and Benefits



©LNS Research. All Rights Reserved.

## AR and Industrial Transformation (IX) Success

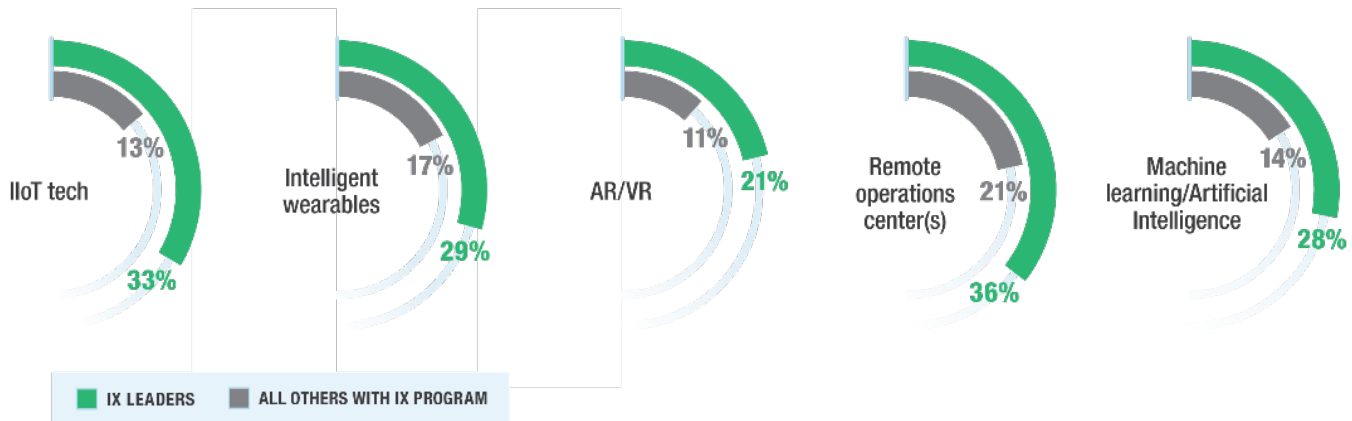
As industrial organizations continue to implement IX programs, there is compelling evidence that AR-enabled use cases should be incorporated appropriately. Our research shows that organizations that are IX Leaders are more likely to implement a variety of Connected Worker technologies than IX Followers, including AR and other digital technologies that are closely related and often part of an AR solution:

- Augmented Reality/Virtual Reality – 90% more likely
- Intelligent wearable technology – 70% more likely
- IIoT technologies – 154% more likely
- Machine Learning/Artificial Intelligence – 100% more likely
- Remote operations centers – 71% more likely

This indicates that there is an attractive opportunity for industrial organizations to be proactive in incorporating Connected Worker initiatives into their IX programs, with AR being among the technologies showing strong potential to support transformation success with productivity, quality and safety benefits.

## Transforming Frontline Operations with Augmented Reality Technology

### Connected Worker Technology Adoption



©LNS Research. All Rights Reserved.

## Industrial Skills Gap Challenge

Several interrelated forces have combined to create a pressing industry-wide challenge: a global talent and skills shortage in manufacturing and other industrial operations. The major force is an aging workforce that is rapidly retiring, with valuable skills, experience, and institutional knowledge being lost.

Also contributing to the problem is that the widespread implementation of IX programs is introducing a wide array of new digital technologies into industrial operations, such as IIoT platforms, automation systems, and robotics, among many others. This trend changes the competencies needed to effectively deploy technology and provide the operational agility required to respond to dynamic production environments. Another trend is that younger employees entering the workforce and advancing through the ranks are digital natives with an entirely new set of perceptions and expectations regarding technology.

The skills gap produced by the convergence of these forces along with a generally tight labor market in many regions makes it challenging for industrial organizations to find, hire, train, retain, and upskill a qualified workforce with right competency profile. How serious is this global problem? Its critical nature is illustrated by these observations:

- The inability to attract and retain a quality workforce was named as the top operational concern by U.S. manufacturers in a 2019 survey, cited by 63.8% of respondents. [Source: [National Association of Manufacturers Outlook Survey, December 2019](#)]
- 81% of manufacturers in the United Kingdom reported difficulties with finding staff with the right qualifications and experience in 2019. [Source: [British Chambers of Commerce](#) [ Source: [The Guardian](#)]

Also contributing to the problem is that the widespread implementation of IX programs is introducing a wide array of new digital technologies into industrial operations, such as IIoT platforms, automation systems, and robotics, among many others.

**Peter Bussey**  
Principal Analyst

## Transforming Frontline Operations with Augmented Reality Technology

- The Manufacturing Institute estimated in 2018 that the widening skills gap could result in 2.4 million unfilled manufacturing jobs through 2028, putting \$454 billion in manufacturing GDP at risk in 2028, or more than \$2.5 trillion over the next decade. [Source: [The Manufacturing Institute](#)]
- In 2018, 24 organizations from 11 European countries launched an EU-funded project to address skills gaps in industries in the automotive supply chain. [Source: [DRIVES](#)]

To be competitive industrial organizations must address the skills gap with a strategic approach that recognizes both the risks and opportunities presented by these workforce trends. This includes rethinking how the frontline workforce is managed, meeting new expectations regarding technology in the workplace, and having a plan to leverage Connected Worker digital technologies. All of these should be brought to bear to meet the unprecedented challenges in hiring, training, and retaining a qualified workforce with the right competency profile over time.

### Augmenting Human Capabilities with Industrial AR Solutions

The promise of AR in industrial settings is to augment human capabilities by enhancing how people interact with their work environment, including human-machine interaction. AR solutions enable this by superimposing virtual objects and digital content on the real environment, while ensuring correct alignment of the virtual world with the physical one in real time. AR incorporates virtual content into a real three-dimensional scene.

Industrial AR solutions are built from various combinations of software platforms, hardware infrastructure, content, and services. A typical system includes a mobile computing platform, software application authoring platform, detection and tracking to align virtual content with physical objects, display, wireless communication, network connectivity, and data management and analytics. Applications may be run on-premises or in the cloud. The end-user display is usually a mobile device, either a Handheld Device (HHD) such as smart phones or tablets, or a Head Mounted Display (HMD) such as smart glasses or some other wearable form factor, e.g., helmet mounted.

AR solutions have been successfully deployed in a wide range of industry sectors and operational domains. A comprehensive survey of industrial augmented reality research and patent activity published in 2020 provides valuable insights into where the AR activity is by industry, functional domain, and targeted benefits:

Industry sectors with the most AR implementation activity were (in descending order): automotive, industrial machinery and components, electronics, aerospace and defense, construction/facility management, and energy.

## Transforming Frontline Operations with Augmented Reality Technology

The most common use case/process categories in manufacturing were (in descending order): assembly, robot programming/operation, maintenance, training, process monitoring, process simulation, quality inspection, picking, operational setup, and ergonomics/safety.

The top benefits of integrating AR technology into the production environment were identified as: reduced execution time, increased production flexibility, improved quality, improved learning, improved safety and health, and decision-support.

[Source: [Cardoso et al., 2020. A Survey of Industrial Augmented Reality. Computers & Industrial Engineering, January 2020](#)]

### High Potential Use Cases Enabled by Augmented Reality

Our research shows that Augmented Reality/Virtual Reality (AR/VR) solutions have had significant adoption in industry, on par with adoption rates of other digital technologies such as drones, intelligent wearables, and robotics. More than a third of industrial organizations report having implemented AR/VR or currently piloting these solutions. Another third has already budgeted an AR/VR project. Comparisons with adoption rates of other digital technologies are provided in the table below:

Technology	Imple-mented	Piloting	Budgeted -1 year	Budgeted- 3 years	No plans
AR/VR	15%	21%	22%	13%	35%
Drones	14%	16%	21%	16%	40%
Intelligent Wearables	22%	24%	21%	15%	25%
Robotics	19%	19%	20%	19%	28%

One of the main challenges in IX initiatives is selecting the right problems to solve. It's also a key to success. Many organizations struggle to identify which use cases to focus on and at what point to do so along the IX journey. Our research assessed IX use cases based on the expected impact on operational performance relative to the effort and resources needed to implement.

Connected Asset and Operations use cases feature prominently as having highly favorable effort-reward ratios, as do Connected Worker use cases. Not surprisingly, the Connected Worker use cases with the highest potential help address the critical workforce demographic and skills gap challenges faced in all industrial sectors:

- AR/mobile to scale rare/expert skills
- AR/mobile for digital work instructions

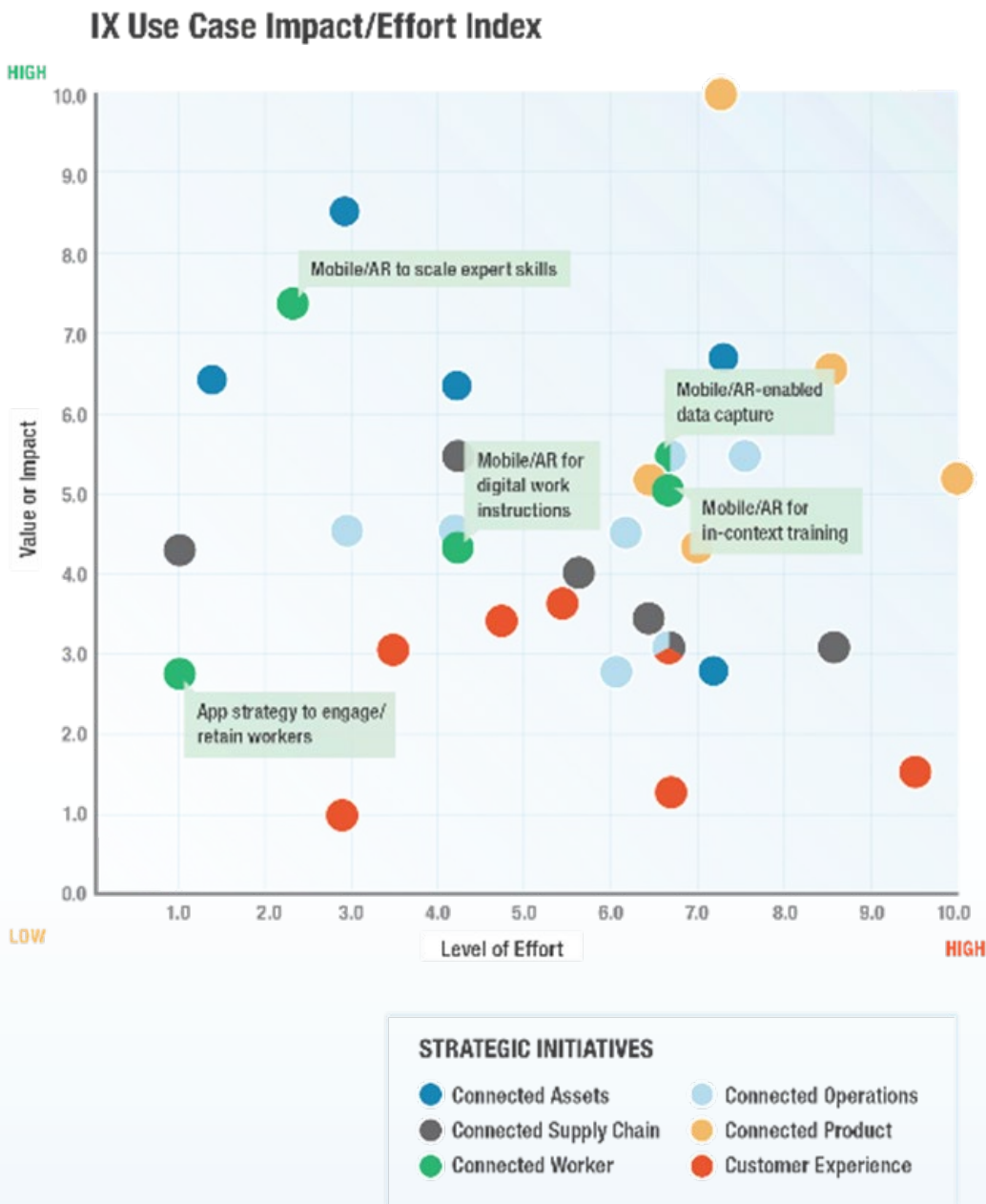
Not surprisingly, the Connected Worker use cases with the highest potential help address the critical workforce demographic and skill gap challenges faced in all industrial sectors.

**Peter Bussey**  
Principal Analyst

# Transforming Frontline Operations with Augmented Reality Technology

- AR/mobile for in-context training (micro-training)
- Application strategy to improve worker engagement/retention

A key observation is that these high potential Connected Worker use cases are enabled by AR and mobile technology. This is not surprising given the significant cross-industry AR adoption rates noted above. It should also be noted that since Connected Worker use cases tend to be



©LNS Research. All Rights Reserved.

cross-functional, many of the use cases classified as Connected Assets or Operations in many cases would be enabled by AR solutions as well, e.g., asset maintenance, field service, etc.

The approach used to select Connected Worker use cases for implementation will vary by organization and depend on the status and capabilities of the IX initiative overall. Many organizations have met with success by initially focusing on relatively low effort, quick win projects that solve a well-defined, important business problem. Candidate use cases should be quantitatively assessed by their impact, resources required, and cultural readiness.

## Path Forward and Recommendations:

As Industrial Transformation (IX) programs ramp up throughout industry, Connected Worker initiatives are fast becoming integral to them. Augmented Reality (AR) is one of the key digital technologies that has been successfully deployed in industrial operations to improve productivity, quality, and safety. Our research shows that AR enables a variety of high-value use cases such as remote expert access, digital work instructions, and in-context training that not only contribute to operational performance improvement, but also directly help to address the workforce skills gap challenges that threaten to hold back manufacturing and other industrial sectors.

We suggest that industrial organizations proactively consider incorporating AR into their IX programs and provide the following recommendations to guide efforts.

- 1. Select use cases for investment based on expected business outcomes.** Our digital readiness research shows that industrial organizations should be careful to start with a clear focus on process improvement and desired business outcomes, rather than technology evaluation/testing per se. Candidate use cases should be assessed using a structured approach that considers expected impact, resources, and cultural readiness.
- 2. Scale success broadly by deploying winners across global operations.** A best practice recommendation from our IX research is to first go broad rather than deep. Focus on solving specific problems and showing value in production at one or a few sites, then roll that success out across global operations.
- 3. Strive for enterprise standardization.** AR solutions can enable a diverse set of use cases throughout value chain operations, ranging from R&D to manufacturing to field service. IX leaders tend to have more commonality in IT and OT systems; standardizing on an enterprise AR platform to the extent feasible can reduce complexity and costs while improving results.



- 4. Harness the power of advanced analytics including AI.** The greatest strategic value of the Connected Worker opportunity comes from applying AI and other advanced analytics tools to IIoT-generated Big Data on human-workplace interactions to glean actionable insights at the line, business unit, and enterprise levels. This may or may not be part of phase one but should be given priority in the Connected Worker roadmap.

## Presented by:



## Author(s):

Peter S. Bussey,  
*Principal Analyst*  
[peter.bussey@lns-global.com](mailto:peter.bussey@lns-global.com)

Matthew Littlefield,  
*President & Principal Analyst*  
[matthew.littlefield@lns-global.com](mailto:matthew.littlefield@lns-global.com)

Vivek Murugesan,  
*Research Associate*  
[vivek.murugesan@lns-global.com](mailto:vivek.murugesan@lns-global.com)

LNS Research provides research and advisory services to guide companies through industrial transformations. Our research focuses on how digital technology drives industrial transformation across the value chain and offers insights into the people, processes, and technologies required for achieving Operational Excellence. Learn more at [www.lnsresearch.com](http://www.lnsresearch.com).