

IoT Digital Transformation: Why Industrial Organizations Must Retrain the Workforce

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We discussed the Industrial Internet of Things (IIoT) landscape in our first white paper, “Prepare to Succeed with the Internet of Things.” And we moved into describing the necessary IIoT operational changes in our second white paper, “IoT Digital Transformation: Changes in Manufacturing Processes Can Boost Competitiveness.” (Both papers can be found in our [white paper library](#).) In this third paper in the series, we will introduce the necessity of retraining the industrial workforce to take on this digital transformation.

For the purposes of this paper, the Internet of Things (IoT) refers to the broad world of connected devices. The Industrial Internet of Things (IIoT) refers specifically to IoT in an industrial setting.

Most companies venturing into IIoT must address not only its operational aspects, but also the immediate training needs specific to the “network of networks.” As industrial organizations begin to converge their networks with their IT infrastructures, the skills required to manage this convergence are becoming a priority. This is the first order of learning in industrial IoT if a manufacturing facility is to be successful in launching this new phase of connectivity.

However, it isn't “all technology.” The human factor must be considered along with the technological factor. Those connectivity job roles must include associated training and certifications. But is that happening?

Yes, but not quickly enough, it turns out. Nearly 90 percent of respondents to a 2015 global survey of managers and executives conducted by MIT Sloan Management Review and Deloitte anticipated that their industries would be disrupted by digital trends to a great or moderate extent. But only 44 percent said their organizations were adequately preparing for the disruptions to come.¹

Even so, how well are they really preparing? IIoT requires a huge leap, not only in technology but also in the willingness of management to take on risk, to entertain the idea of breaking rules, and to understand that IIoT reaches into all aspects of the organization. It isn't a concept for only one division or a single function. And it isn't something that only the IT staff will need to delve into.

As stated in an article in Industry Week, “With smart manufacturing, organizations can predictively meet business needs through intelligent and automated actions driven by previously inaccessible insights from the physical world.”² Smart manufacturing transforms businesses into proactive, autonomic

1. Gerald C. Kane et al.; MIT Sloan Management Review, “[Aligning the Organization for Its Digital Future](#),” July 26, 2016.
2. Kevin O'Marah and Pierfrancesco Manenti; Industry Week, “[The Internet of Things Will Make Manufacturing Smarter](#),” August 14, 2015.

GE's Durathon battery plants have more than 10,000 sensors to measure real-time temperature, humidity, air pressure, and machine operating data.

organizations that predict and fix potentially disruptive issues, evolve operations, and delight customers, all while increasing the bottom line.”

Despite the hesitation on some fronts, organizations are taking the leap. The article lists several manufacturing companies that already use IoT technology for these purposes. Siemens, for example, has machines and computers controlling 75 percent of the value chain autonomously at its plant in Amberg, Germany. GE's Durathon battery plants have more than 10,000 sensors to measure real-time temperature, humidity, air pressure, and machine operating data. And much of Harley-Davidson's manufacturing plant turnaround in Pennsylvania is being credited to its connected processes.

With this new technology, companies can have more accurate and timely process readouts, they can react immediately to any anomalies in the manufacturing process, they can reduce costly downtime, and they can ship more products with fewer failures, among other business benefits.

There are other examples of companies taking a leadership role in this transition. In perhaps one of the most impressive retraining efforts, as noted by Fortune magazine, AT&T looked inward to upskill more than 100,000 of its employees.

The company had realized that its old technologies were not working well enough to serve customers who demanded more digital options. Rather than issue mass layoffs and try to hire people with the required skills, AT&T chose to rely on the people who already knew the company—its existing employees.³

That decision helped to land AT&T for the first time on Fortune's 2017 list of “100 Best Companies to Work For.”⁴ Had the company moved to hire already-trained personnel, it would have found slim pickings. Not enough available workers possess the required training, even though the field is wide open. Thus, companies are wise to remain loyal to current employees and retrain them, using new hires to fill in the gaps.

OT positions will undergo many changes

Even with all these benefits, introducing IIoT could signal the demise of many operational jobs in industrial settings. Operational technology (OT) professionals who perform repetitive jobs will be replaced by automation. Meanwhile, deployment and operations engineers must be reskilled to understand IIoT if they are to successfully administer, configure, deploy, monitor, and troubleshoot networks to support the organization's business outcomes.

These changes are already happening in the retail world. Fellow Robots, for example, is currently partnering with Lowe's to install robots that know where all the store's merchandise is located, know how to help customers

3. Aaron Pressman; Fortune, “[100 Best Companies to Work For: Can AT&T Retrain 100,000 People?](#)” March 13, 2017.

4. Fortune, “[100 Best Companies to Work For](#),” March 13, 2017.

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find items, and can even work the checkout counter. Some companies are investigating the use of robots as security personnel, detecting intruders after business hours.

We are witnessing the start of what has been called Industry 4.0. Peter Diamandis, founder and executive chairman of the XPRIZE Foundation, has predicted that technologies that are growing exponentially will displace 40 percent of Fortune 500 companies in the next decade.⁵ Employers must reskill or upskill their personnel, or they will lose workers who have supported the enterprise, perhaps for years.

Diamandis also says that a significant number of plant workers will work alongside automated assistance technologies toward the end of this decade. Forward-thinking enterprises will join the movement. This means that supply chain, plant operations, and product and service life-cycle management will be more cohesive and more integrated to take advantage of this digital transformation.

Only 3 percent of industrial engineers are 24 years old or younger, and the average age of the majority is 43.2.⁶ Spending most of their career at the same company is common. The workforce retirement begins after age 52.⁷ It's obvious that without an influx of new talent, in-house talent must be upskilled to take on the IIoT opportunity. This means that, as we move into Industry 4.0, companies that nurture the workforce in IIoT technologies, "soft" skills, and innovative thinking will become the new leaders, investing in the future.

Invest in your "people asset"

Management must realize that it cannot afford to take the traditional approach of simply sending an engineer or two for product training whenever new equipment is being shipped to the plant. Learning about a new production robot or a connected 3-D printer will not automatically bring a company into the IIoT orbit. Full integration will require some changes in management approach. Instead of product training alone, management should invest in job-role-based skills training, because these skill sets are transferrable and evolvable.

Is this training worth the investment? Let's put it this way. If your personnel are not properly trained in these new technologies, they cannot fully leverage them to deliver optimum benefits to your organization. And those benefits can be impressive. For example, in its IoT Barometer 2017/18, Vodafone reported that organizations seeing increased revenue from adopting IoT said the increase averaged 19 percent.⁸ And those that saw a reduction in operating costs reported that the decrease averaged 16 percent. Of all companies

5. CNBC, "[A Decade to Mass Extinction Event in S&P 500](#)," June 2014.

6. StudentScholarships.org, [Industrial and Manufacturing Engineers](#), 2017.

7. Data USA, [Industrial Engineers, Including Health and Safety](#).

8. Vodafone, [The IoT Barometer 2017/18](#).

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reporting, 66 percent claimed that digital transformation is not possible without IoT. The report also noted that the number of companies with more than 50,000 active connected devices had doubled in the past 12 months. In fact, of all IoT adopters reporting, 84 percent said their IoT implementation had increased in the past year.

However, other facets must be considered. Anything connected to the Internet is vulnerable, so protecting that data is becoming more critical. CIO magazine says that security engineering is growing by 83 percent (increase in demand for IoT skills year over year), including vulnerability assessment and endpoint security. Jobs in security infrastructure are also growing by 83 percent.

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Gartner also has identified ten of the best skills to have for IoT success.¹⁰ Cisco can provide training for many of them:

- **IoT security**—New threats will emerge through 2021 as cybercriminals turn their attention to attacking IoT devices and protocols. Connected “things” may need updatable hardware and software to adapt and defend themselves during their lifespans. Therefore, your workforce will need IoT security training, such as the [Securing Industrial IoT Networks with Cisco Technologies \(ISECIN\)](#) course.
- **Low-power, short-range IoT networks**—Selecting a wireless network for an IoT device involves balancing conflicting requirements, such as range, battery life, bandwidth, density, endpoint cost, and operational cost. This kind of decision requires people who are experts in configuring, deploying, and managing wireless endpoint devices. This knowledge is covered in the [Managing Industrial Networks for Manufacturing with Cisco Technologies \(IMINS2\)](#) course.
- **Low-power, wide-area networks**—The first low-power wide-area networks (LPWANs) were based on proprietary technologies, but in the long term, emerging standards such as narrowband IoT (NB-IoT) will likely dominate this space. The ideal job candidates will be trained in how to configure, deploy, and manage LPWANs. This knowledge also is included in Cisco’s IMINS2 course.
- **IoT processors**—Understanding the implications of processor choices will demand deep technical skill. Your workforce should include those trained in the specific skills related to your particular industry. For example, consumer-serving industries may focus more on mobile OS-based systems. Intel offers training on IoT processors.

9. Sharon Florentine; CIO, “[10 Most In-Demand Internet of Things Skills](#),” September 21, 2017.

10. David Oro; IoT Central, “[Gartner Identifies the Top 10 Internet of Things Technologies for 2017 and 2018](#),” March 1, 2016.

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- **IoT operating systems**—A wide range of IoT-specific operating systems has been developed to suit many different hardware footprints and feature needs. That requires people who are trained in skills specific to your industry. Microsoft provides IoT operating systems training.
- **Event stream processing**—Distributed stream computing platforms (DSCPs) have emerged that typically use parallel architectures to process very high-rate data streams to perform tasks such as real-time analytics and pattern identification. At least some of your workforce should be trained in the specifics for your industry. For example, with industrial systems, engineers must understand distributed intelligence and analytics from the edge to the core and cloud.
- **IoT platforms**—IoT platforms bundle many of the infrastructure components of an IoT system into a single product. Train at least some of your workforce in the relevant Cisco validated designs for various industries. For example, Converged Plantwide Ethernet (CPwE) training would be ideal for the manufacturing sector. Some of this training can be found in Cisco's IMINS2 course.
- **IoT standards and ecosystems**—IoT devices must interoperate and communicate, and many IoT business models will rely on sharing data among multiple devices and organizations. It will be necessary to train the workforce in industrial and IP networking standards, as well as in the skills covered in the ISECIN course. Training in IMINS and IMINS2 is also valuable.

See the last section of this paper for more details about all of our training programs and for the links to each one.

Take the long view

As you can see, these IoT skills go far beyond simply understanding how to operate a machine or a new software program. They involve the very guts of an industrial organization's operation—and even its future success and viability. That fact makes employee training essential for any industrial organization that is planning to be around in the next ten or more years.

For one-and-done projects, it might be reasonable to outsource the integration to consultants. However, most IIoT solutions evolve from efficiency to cost improvements and eventually to differentiated and profitable solutions. This evolution is part of an ongoing journey, so it makes sense to develop in-house talent to maintain continuity while sequentially improving business outcomes.

Developing critical job roles in-house, from solutions architects to IoT network engineers, must be considered essential to maintaining a level of expertise in the organization for continuous improvement and solutions evolution.

The Cisco Learning Network covers a broad range of certifications for those in technology careers.

An IoT project workflow builds up from the foundation and iterates for continuous added value. The phases and those responsible for each phase are as follows:

1. Plan and design: leadership, solutions and systems architects, engineers
2. Deploy and connect: IT and OT network engineers, system integrators
3. Operate and maintain: business process, plant administration, OT, support
4. Create solutions and applications: software developers
5. Protect and defend: security managers, engineers
6. Analyze and refine (back to phase 1): solutions and operations analysts

Apart from OT and IT network engineers, generalists can be business unit sponsors, business and solutions architects, project managers, cross-functional team leaders (such as analysts, operations, and support staff), service developers, partners, QA engineers, and more.

As the work environment transitions from the hierarchical [Purdue](#) model to a flattened IP-connected world (explained in our second IIoT white paper, “IoT Digital Transformation: Changes in Manufacturing Processes Can Boost Competitiveness,” located in our [white paper library](#)), it is essential for OT engineers to understand IP networking protocols and the implications of sharing data with the rest of the ecosystem. This involves operations, business processes, and collaborator components from the extended digital network architecture, such as supply chain and logistics. The closed plant floor will become Internet enabled, and the probability for job obsolescence is high. It is “sink or swim” not only for those employees, but also for management, whose priority is to keep the company competitive throughout these technology changes.

Cisco is here to help

Cisco is a founding member of the [IoT Talent Consortium](#), launched in 2015 as an outgrowth of the [Internet of Things World Forum](#) (of which Cisco is also a founding member). The consortium’s focus is on accelerating preparation of the first generation of IoT-ready talent to manage the first wave of IoT installations.

[The Cisco Learning Network](#) covers a broad range of certifications for those in technology careers. Cisco IoT training and certification options are an extension of its global-leading certifications for routing and switching. Certification and training courses include the following:

- A Cisco Technical Specialist certification, [Cisco Industrial Networking Specialist](#), prepares IT and OT professionals in the manufacturing, process control, and oil and gas industries who will be involved in the implementation, operation, and support of networked industrial products and solutions. To earn this certification, candidates must pass the 200-401 IMINS exam.

The Cisco CCNA Industrial certification is for plant administrators, control system engineers, and traditional network engineers in the manufacturing, process control, and oil and gas industries who will be involved with the convergence of IT and industrial networks.

The [Managing Industrial Networks with Cisco Networking Technologies \(IMINS\)](#) course prepares candidates for the exam. This lab-based course provides the foundational skills to manage and administer networked industrial control systems. It is appropriate for plant administrators, control system engineers, and traditional network engineers who must understand the networking technologies necessary in connected plants and enterprises.

For those who are just beginning in this area, two e-learning modules may be valuable to prepare for this certification:

- The [Control Systems Fundamentals for Industrial Networking \(ICINS\)](#) course teaches IT and network engineers basic concepts in industrial control systems. It provides an introduction to automation industry verticals, automation environment, and an overview of the industrial control networks.
- The [Networking Fundamentals for Industrial Control Systems \(INICS\)](#) course provides industrial engineers and control system technicians with basic IP and networking knowledge. The course covers concepts in networking and an introductory overview of automation industry protocols.
- The [Cisco CCNA Industrial](#) certification is for plant administrators, control system engineers, and traditional network engineers in the manufacturing, process control, and oil and gas industries who will be involved with the convergence of IT and industrial networks. To earn this certification, students must pass the 200-601 IMINS2 exam.
- The [Managing Industrial Networks for Manufacturing with Cisco Technologies \(IMINS2\)](#) course, for IT and OT professionals, covers best practices in security and wireless technologies for industrial networks. It caters to plant administrators, control systems engineers, and traditional network engineers in the oil and gas, process control, and manufacturing industries who are involved with the convergence of IT and industrial networks.
- The [Securing Industrial IoT Networks with Cisco Technologies \(ISECIN\)](#) course addresses the critical need to prepare security professionals to understand the additional vulnerabilities of IoT-enabled infrastructures and to defend against threats to them. The course explains IoT architecture, components, and applications and describes best practices to secure and monitor them, as well as to respond to attacks.

For more details on these and other [Cisco courses for IoT](#), please visit our website.

You can see why
it's also important
to reskill your
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Reskilling is essential—start now!

In our previous white papers, we presented the IIoT landscape and described the changes necessary to have a successful, digitally connected manufacturing process. Now you can see why it's also important to reskill your current workforce. In fact, you may have to invest in upgrading the skills of new hires, as well, because many of those available will not have the specific training needed for this new wave in manufacturing.

Cisco recommends that you start that training immediately so that your people at every level will have the critical new skills to help your organization through the transformation process.