

Industry 4.0 User's Guide:
Educator Edition

FESTO



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The Rise of Worker 4.0

Robotics. Artificial intelligence. Data. Virtual ecosystems. Rapid prototyping. These are the hallmarks of Industry 4.0, also referred to as the fourth industrial revolution. Industry 4.0 follows the innovations of water and steam power in Industry 1.0, electrical power in Industry 2.0, and information technology and electronics in Industry 3.0. It is an evolution in industry that represents a paradigm shift from the assembly lines popularized by the U.S. automotive industry. Whereas the values typified by those initial factories prioritized profitability over people and safety standards, modern manufacturing has evolved to place an equally high value on clean technology, virtual ecosystems, collaborative robots, and on-demand, yet affordable, customization. But most notably, Industry 4.0 is giving rise to the demand for a new kind of employee: Worker 4.0.

People who are considered Worker 4.0 are currently in manufacturing-related degree programs in colleges and universities across the country. Or perhaps Worker 4.0 will be arriving on campus soon as a current manufacturing employee needing to update his or her skills. As the U.S. rapidly converts to a new type of industrial economy of automation and workflow optimization, low-skill jobs are disappearing.¹ Careers in Industry 4.0 are highly technical roles that require some post-secondary education and a mix of hard and soft skills. Skills like computer programming, problem solving, creativity, and mathematics are all essential for Worker 4.0 to possess.

To train Worker 4.0 effectively, educators must adapt the current formats and contents of degrees and training programs. Industry 4.0 continues to push innovations at lightning speed, meaning partnership and collaboration with employers is vital. Hands-on training methods may also need to be updated, as Worker 4.0 will be using more advanced technologies in the workplace than exist on college campuses today. Exploring other avenues of education, such as apprenticeships and certifications, to complement these hands-on training exercises is also essential in preparing Worker 4.0. Proper and holistic Industry 4.0 training will empower the next generation of manufacturing workers to learn beyond techniques and will give them access to the type of hands-on training and information they need to become industry experts for long-lasting careers.

This guide provides a look at what educators need to know about Industry 4.0 and how they can best prepare Worker 4.0 for the realities of the current and future factory.



Skills Gap:

There is a growing skills gap in manufacturing, perpetuated by lack of training on new skills, a quickly retiring workforce of Baby Boomers, and a shortage of new workers to fill their spot. Neglecting the information in this guide could exacerbate the deficit of skilled workers, causing more damage to employers, educational programs, and individuals.



Specifications

There are many parts in the Industry 4.0 ecosystem. Each element represents a small but substantial evolution for manufacturing and impacts what Worker 4.0 needs to know and do to get jobs of the future. Taken together, these components show the seismic shift of the fourth industrial revolution.

Automation

- Clean technology
- Efficiency
- Robotics
- Self learning
- Decentralization
- Artificial Intelligence
- Productivity
- Smart Networking
- Wireless Communication

Virtual ecosystems

- Rapid prototyping
- On-demand customization
- Simulation
- Industrial Internet of Things
 - Two-way communication
 - Real-time analytics
 - Efficiency
 - Big Data
- Connected machines
 - Cobots

Training

- Apprenticeships
- Certification
- Cross-disciplinary
- Hands-on learning
- Higher education
- Industry collaboration
- Jobs of the future
 - Middle-skills jobs
 - High-skills jobs
- Simulation



Tools and Skills

Tools

- College degree
- Technical training
- Hands-on learning
- On-the-job training

Skills

- Computer programming
- Critical thinking
- Engineering design mindset
- Entrepreneurial mindset
- Industrial design thinking
- Ingenuity
- Math
- Analyzing and interpreting data
- Problem solving
- Communication skills



Features of Industry 4.0 Education

Apprenticeships

Learn, practice, work: the apprenticeship trifecta. Apprenticeships teach Worker 4.0 the theories and principles of manufacturing and how to translate that knowledge into a work environment during on-the-job training. Careers in smart factories require highly specific and hard-to-obtain hard and soft skills. The mix of classroom instruction and training under the guidance of an experienced technician makes apprenticeships effective in preparing their graduates for the jobs of the future. Apprenticeships are on the rise, as there are currently 505,000 registered apprenticeships according to the U.S. Department of Labor (DoL).

Certification

Certification Programs allow workers to acquire and demonstrate specific skills in short amounts of time. These types of programs are great extensions of the education individuals get during two- or four-year degree programs and help reduce the amount of on-the-job training required for new employees. Their condensed and focused structure means the content of certification programs can more easily keep pace with industry growth, evolving as technology in manufacturing changes. They are especially valuable for older workers who may need to develop new skills required in Industry 4.0.

Cross-learning and training

Working in advanced manufacturing requires a broad understanding of the factory's processes. No longer do workers simply pull a lever or lift heavy objects manually. Worker 4.0 needs a mix of knowledge from engineering, mathematics, computer science, and other disciplines to undertake complex problem solving. Additionally, the future of work is collaboration. New workers will regularly use soft skills such as written and verbal communication as they work with their bosses, with their team members, and with colleagues in other departments.

Hands-on training

Hands-on training turns learning into doing for the next generation of manufacturing workers. Training on equipment that resembles real-world labs makes future careers feel tangible and deepens students' understanding of what they learn in class. When colleges invest in technology, whether that be equipment, simulations, or both, they help prepare students for a successful future.

Partnership

Industry 4.0 is a fast-evolving change to how manufacturing functions. Educators cannot possibly keep up with the shifts happening on factory floors on their own. Partnerships with industry, government, associations, and other organizations are essential. Each partner has their role. Educators know the best ways to teach and train Worker 4.0, but turning to external partners to build industry expertise and access equipment will accelerate instructors' ability to keep pace with change. Partnerships will come in many forms, including the previously mentioned apprenticeships and certifications, but also as advisory councils, classroom speakers, workforce development programs, and other configurations.



Maintenance and Care

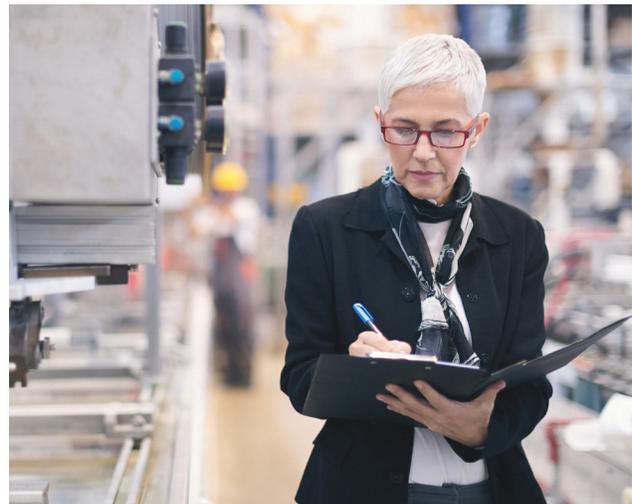
The changes Worker 4.0 will feel from the fourth industrial revolution will not stop with what has already taken place. Manufacturing will continue to evolve and require new skills from the workforce. To keep up, employees, educators, and employers will need to commit to evolving continuously as the industry does. From the workforce, this will take developing a mindset of lifelong learning. School will no longer be a discrete, one-time part of Worker 4.0's life. Instead, learning will be more like a cycle in which individuals will learn, and likely acquire credentials, throughout their careers.

The responsibility of lifelong education will not be Worker 4.0's alone. Employers must support continuous learning through policies and practices. This could mean greater investments in new workforce development programs, such as apprenticeships and stackable certifications, and certainly will require deep partnership with educators. Educators should know the best practices in teaching and training, ensuring high-quality curricula that help Worker 4.0 develop critical skills quickly. Employers will be able to share what changes are happening today and what is expected of tomorrow, as well as provide opportunities for on-the-job training. Establishing symbiotic relationships between employers and educators where the two groups share this knowledge and expertise, as well as resources, is paramount to sustaining success in Industry 4.0. Without this kind of ongoing maintenance and dedication to lifelong learning, workers may suffer from high unemployment rates, and the U.S. manufacturing industry will decline. Yet if all parties earnestly invest in continuous evolution and constant communication, there is a bright future for Worker 4.0 and all who support this next generation of manufacturing employees.



Future of Manufacturing Education:

Current cultural perceptions of manufacturing are prohibitive in recruiting Worker 4.0. Ideas about dusty factory floors, low pay, lack of job security, and unsophisticated technology persist. The change Industry 4.0 is bringing is an opportunity to rewrite the story to show how manufacturing is evolving and the critical role it plays in society. Education must adapt to highlight these changes and attract students to manufacturing careers.





The Numbers That Make Worker 4.0

Industry 4.0 is changing manufacturing. Sophisticated technologies and new processes create efficiencies and drive revenue for employers.

By 2020:



70% of manufacturing companies expect to be Industry 4.0-ready.

Companies will see:

- **\$493 billion** annual increase in digital revenue globally
- **\$421 billion** annual cost reduction globally²
- **2.1 million** new jobs created by advanced manufacturing practices³
- But, **3.8 million** manufacturing workers are 55 and older, meaning they will likely retire in the next 20 years and increase the number of job openings.⁴

Running these new smart factories requires a new kind of employee – Worker 4.0 – with a new skill set.



Top 10 Worker 4.0 Skills:

- | | | |
|----------------------------|----------------------------------|--|
| 1. Complex problem solving | 5. Coordinating with others | 9. Negotiation |
| 2. Critical thinking | 6. Emotional intelligence | 10. Cognitive flexibility ⁵ |
| 3. Creativity | 7. Judgement and decision making | |
| 4. People management | 8. Service orientation | |



Employability:

Failure by Worker 4.0 and educators to recognize the changes brought by Industry 4.0 will hurt the employability of individual manufacturing workers. Low-skills jobs are disappearing as machines and robots increasingly take over the rote responsibilities of workers. The jobs of the future will be middle-skill and high-skill positions and employees will need to develop the capabilities to fill them.

Industry 4.0 is changing the nature of careers in manufacturing as low-skills jobs are replaced by middle- and high-skills careers.



54% of jobs in the U.S. are middle-skills jobs, but only 44% of the workforce have the skills needed for these positions.



20% of workforce is trained for low-skills positions, but these positions make up only 15% of job demand.⁶

The shift in expertise needed in the industry is creating a skills gap for Worker 4.0.

2 million jobs will go unfilled because of the skills gap.

Percent of employers that say Worker 4.0 is missing particular skills:

70% technology and computer skills

69% problem-solving skills

67% basic technical training

60% math skills⁷

To develop these skills and qualify for the new careers of Industry 4.0, Worker 4.0 will need a combination of formal education, hands-on learning, and on-the-job training. This may include:



A college degree



Apprenticeships



Certification



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