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Enabling Bioindustry 4.0:
Private-public approach to workforce development

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A public-private approach to workforce 4.0 development

Biopharmaceutical companies are actively adopting the principles of Industry 4.0, a convergence of technologies that represent the future of manufacturing.[1] Industry 4.0 encompasses a wide range of advances including digital technologies, artificial intelligence, machine learning, automation, and analytics performed on vast amounts of data. It also applies the principles of lean manufacturing to generate greater output, improve returns on investment, and reduce waste and environmental harm.[2]

The Need for Workforce Evolution

The evolution to Industry 4.0 requires a workforce with new skills, new ways of thinking, and creative problem-solving capabilities. In addition to expertise in the science of biopharmaceutical research and development, companies need employees with an understanding of advanced digitalized and lean biomanufacturing. Today, gaps in the skillsets of new hires and a shortage of trained workers, however, threaten to slow the transition towards digitalizing and automating operations. This is reflected in the results of a 2023 survey of 1,250 biopharma executives across 22 countries which concluded that, among the pressing issues confronting the industry, sourcing talent was a major challenge.[3]

To shape the biopharmaceutical workforce, companies must address the skill gaps among new hires, existing employees, and future generations. Collaborations between industry, governments, and educational institutions are essential to develop and deploy targeted and specialized training programs that encompass traditional scientific disciplines, digital competencies, and practical experience. The traditional focus on biology, biochemistry, pharmacology, and industrial engineering must be supplemented with training on information and operational technology, supported by real-world experience enabled by internships and other hands-on opportunities. In parallel, drug manufacturers must foster continuous learning for existing employees, offer internship opportunities to provide practical experience, and guide academic institutions as they seek to better prepare graduates for employment at Industry 4.0 facilities.

In this paper, we provide greater detail on the workforce challenges presented by Industry 4.0 and highlight exciting new public-private approaches for addressing these needs.

The Challenges of Implementing Industry 4.0

Beyond traditional scientific education in such disciplines as biology and engineering, the modern biopharmaceutical industry demands proficiency in data management, AI, and automation and the like. Transitioning to Industry 4.0 also calls for developing specific soft skills. Adaptability is paramount. In an ever-evolving technological landscape, employees must engage continuously in learning, unlearning, and training to keep their skills in sync with workplace demands.[4]

Reskilling and upskilling are part of the solution and collaborations between businesses and educational institutions are critical – and time is of the essence.

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Potential Hires Are Not Prepared

While new university graduates know the latest scientific concepts, they often lack the full range of skills required to work in modern 4.0 facilities. As manufacturing operations evolve, the skills expected of new hires must also evolve.[5] Adding to this imperative, biopharmaceutical companies compete for talent with many other employers in their own countries and at a global level.[6] As one observer put it, Industry 4.0 "has positioned the sector in direct competition with the technology industry" for talent.[7]

Existing Employees are Not Prepared

While existing employees have the requisite industry experience within their communities of practice, they may lack the skills needed for the transition to Industry 4.0.[8] Lags in workforce training and the skill gaps of many current employees as the industry advances are increasingly evident. In most cases, the growing use of data science, AI, machine learning, process automation, and robotics will not necessarily supplant factory workers. Rather, such usage will substantially alter the characteristics of many jobs, compelling employees to master a broader array of skills than traditionally needed.[9]

Industry Is Not Prepared

Many biopharmaceutical industries have deemed their systems, data and approaches to organization management as being inadequate for the transition to Industry 4.0.[10]

At a fundamental level, managers recognize that change will necessitate a significant cultural shift, one that might be both expensive and disruptive to employees. At all organizational levels, staff may need to embrace entirely new work approaches, as their facilities implement state-of-the-art technologies and processes for realizing operational efficiency.[11] Reskilling and upskilling are part of the solution.

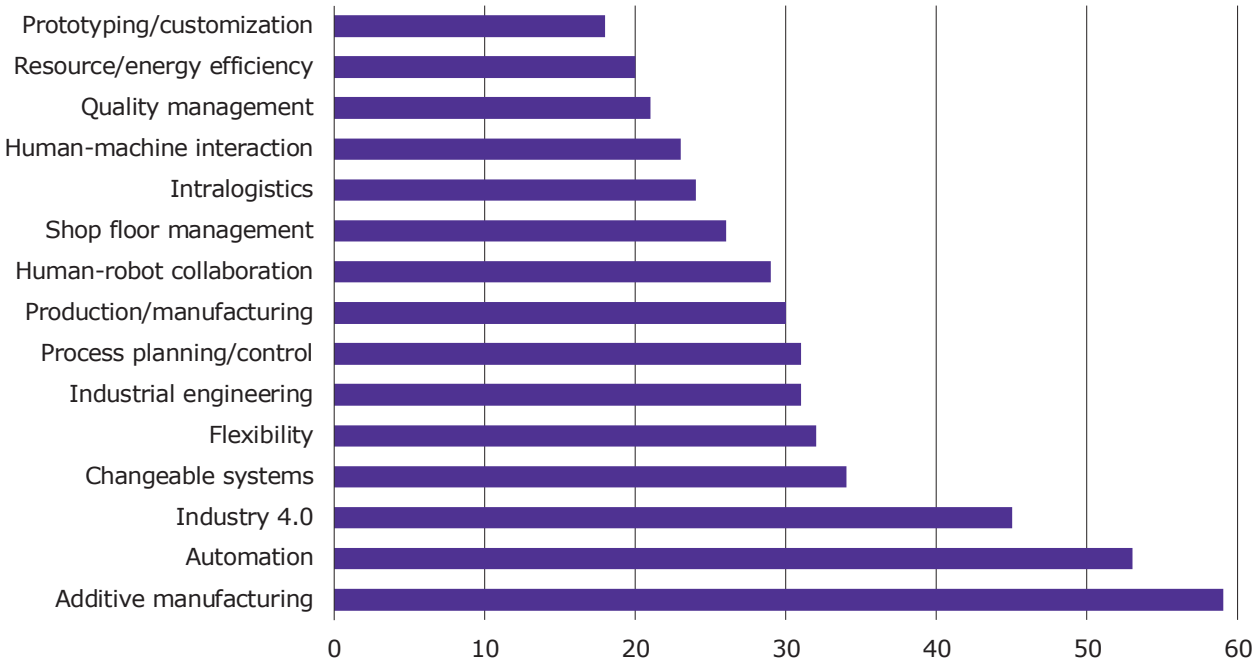

Figure 1. Skills that appear most frequently in curricula of learning factories around the world.

Strategies for Developing a Talent Pipeline

Automation, centralization and new job requirements could affect as much as 90 percent of today's biopharmaceutical manufacturing workforce.[12] To upskill the current workforce and successfully train future workers, employers and other public and private stakeholders need deliberate strategies. Such approaches include:

- **Hands-on Learning Environments:** Establish hands-on educational or proof-of-concept (PoC) spaces known as "learning/collaboration factories" where students can engage in real-world biomanufacturing processes with the latest solutions and technologies.
- **Diverse Hiring Practices:** Seek candidates with a mix of hard and soft skills to foster adaptability and creativity in problem-solving.
- **Promote 4.0-Specific Careers in Biopharmaceutical Manufacturing:** Implement targeted promotional campaigns that highlight the innovative and dynamic nature of careers in Biopharma 4.0.
- **Career Advancement Pathways:** Promote non-traditional routes for career development, including such as retraining workers from other industries including lateral entrants and career changes.
- **Strategic Workforce Planning:** Integrate workforce development into overall operations strategies to ensure alignment with Industry 4.0 requirements.
- **Adapting Existing Training Programs:** Continuously update existing training programs and create new ones that reflect the latest technological advancements.[13]

Targeted government support and strategies for workforce development also will help.[14] Governmental bodies in Europe and other regions have acknowledged as much and are striving to expedite implementation.

National Initiatives to Promote Innovation in Biopharma Manufacturing

Many countries have implemented strategies and established structures for promoting Industry 4.0, such as training the workforce of the future.

For example, with French national and regional governments, the European Investment Bank (EIB) co-financed a project called Bio'Occ (short for "biotherapy and bioproduction in Occitanie") in Toulouse.[15] The project attracted significant funding for the company Evotec and a biomanufacturing training centre at the University of Toulouse.[16]

In a project called CALIPSO (short for "online process sensors and innovative bioproduction solutions"), French public funding helped a consortium of Sanofi, Capgemini, GPC Bio, and other companies to seek "a new paradigm for bioproduction processes," with a goal of designing new digital and connected tools for biomanufacturing that could speed production of certain biologics tenfold.[17]

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The development of training programs in public-private partnerships is an effective approach to supporting biomanufacturing's future workforce.

Learning Factories

Learning factories approximate the experience of biomanufacturing facilities of the future, where staff can safety-test process improvements and modifications in production, and employees can upgrade their skills.[18] Examples of such facilities include the National Institute for Bioprocessing Research and Training (NIBRT) and at the Biomanufacturing Training and Education Center at North Carolina State University. Figure 1 lists the skills that most frequently appear in the curricula of learning factories around the world.[19]

Public–Private Training Initiatives

The development of training programs in public-private partnerships is an effective approach to supporting biomanufacturing's future workforce.[20] By collaborating with industry, universities can keep job candidates up to date on equipment, processes, and regulatory and compliance issues within the industry.[21] Such collaboration also can help to align the requisite skill sets for workers in different entry roles.

To support these training approaches, the European Commission and the member states have expanded funding for advanced biomanufacturing 4.0. A range of diverse biomanufacturing training initiatives based in Europe are responding to this growing Industry 4.0 need.

As part of the *France 2030* re-industrialisation project, the French government has launched the creation of trades and qualification campuses to bring together those involved in training and business. The mission of the new *Biotech-Santé* campus in the AuRA (Auvergne Rhone Alpes) region is to facilitate the transition to Industry 4.0 by providing training in cross-disciplinary skills. In parallel, several technology platforms that mimic industrial environments and equipment are being developed. For example, the Institut Bio3 (Tours, France) and Innobiovir (Lyon, France) offer training to corporate research teams, as well as to university lecturers and students, in areas such as quality control and biomanufacturing. This initiative also provides access to equipment so that students and educators can gain experience in a simulated manufacturing environment.

There are similar initiatives in the United States. For example, the National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL), headquartered at the University of Delaware, publishes training resources, connects training programs with employers and works to promote careers in biomanufacturing among workers with relevant skills in other sectors.[22] It considers strong industry partnerships critical to developing new academic training programs for biomanufacturing 4.0.[23] NIIMBL also forms consortia to identify specific skills that will be needed in the 4.0 workplace.

As a leading, global provider of analytical and digital technologies, Merck Life Sciences is enabling the evolution of biopharmaceutical companies towards Industry 4.0 and is active in a wide range of training initiatives. For example, the company contributes to onsite and remote training in advanced biomanufacturing through its global network of facilities known as M Lab™ Collaboration Centers, including a location in Molsheim, France.[24] The M Lab™ network gives scientists and engineers access to new ideas and techniques, cutting-edge equipment, analytical and modelling support, and other advice from the company's engineering and scientific experts. Merck also founded a consortium that includes academic and industrial organizations, as well as strategic partners specializing in grant acquisition and thought leadership, to support the development of the Industry 4.0 workforce.

The Way Forward

The principles of Industry 4.0 are being integrated into the manufacturing workflows and facilities across the biopharmaceutical industry. To take full advantage of the benefits offered by this evolution, a workforce that is trained and well-versed in the core elements of Industry 4.0 will be essential. Public-private initiatives, such as those described, are well underway and will play a foundational role in nurturing the development of new skills, new ways of thinking, and creative problem-solving capabilities of current and future employees in the industry.

Read the full paper

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