

### SKILLS WANTED FOR SUSTAINABLE INNOVATIONS

# INDUSTRIAL ENGINEER











We're experiencing a global Industry Renaissance today, bringing new ways – real and virtual – of seeing the world, inventing, learning, producing and trading. Tomorrow's game-changers will not be those with the most automated production systems, but those who build a culture of knowledge and know-how to reveal and train the Workforce of the Future, able to solve the challenges of a planet lacking sustainable solutions.

> **BERNARD CHARLÈS** Vice Chairman of the Board and Chief Executive Officer





At Dassault Systèmes, we are convinced that the future is about people, that the only progress is human. In order to create a more sustainable world, people need to be empowered with knowledge and knowhow.

Technologies are reshaping the world of work. Jobs are being transformed and new jobs requiring new skills are emerging. Dassault Systèmes, as a strategic transformation partner for many industrial customers, plays a unique role in this jobs transformation.

At Dassault Systèmes, our **3DEXPERIENCE**® Edu universe is committed to improving people's skills and employability throughout their lifetimes. "To foster industry growth, people must be able to adapt to new ways of working, businesses must equip workers for fast-evolving roles and find workers that have the right skills, and industry must work with educators to reduce the gap between their needs and what is taught in classes," said Florence Verzelen, Executive Vice President, Industry, Marketing and Sustainability, Global Affairs at Dassault Systèmes.



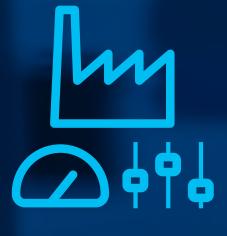






We are very pleased to share this publication from **3DEXPERIENCE** Edu, whose missions include fostering collective intelligence on key emerging roles and skills. This ebook is part of a series of publications called "Skills wanted for sustainable innovations," which share the view of **3DEXPERIENCE** Edu and our ecosystem, on the evolution of the key roles and top skills for the Industry Renaissance. In this ebook, we will focus on the Industrial Engineer role, a critical role within the Manufacturing industry.

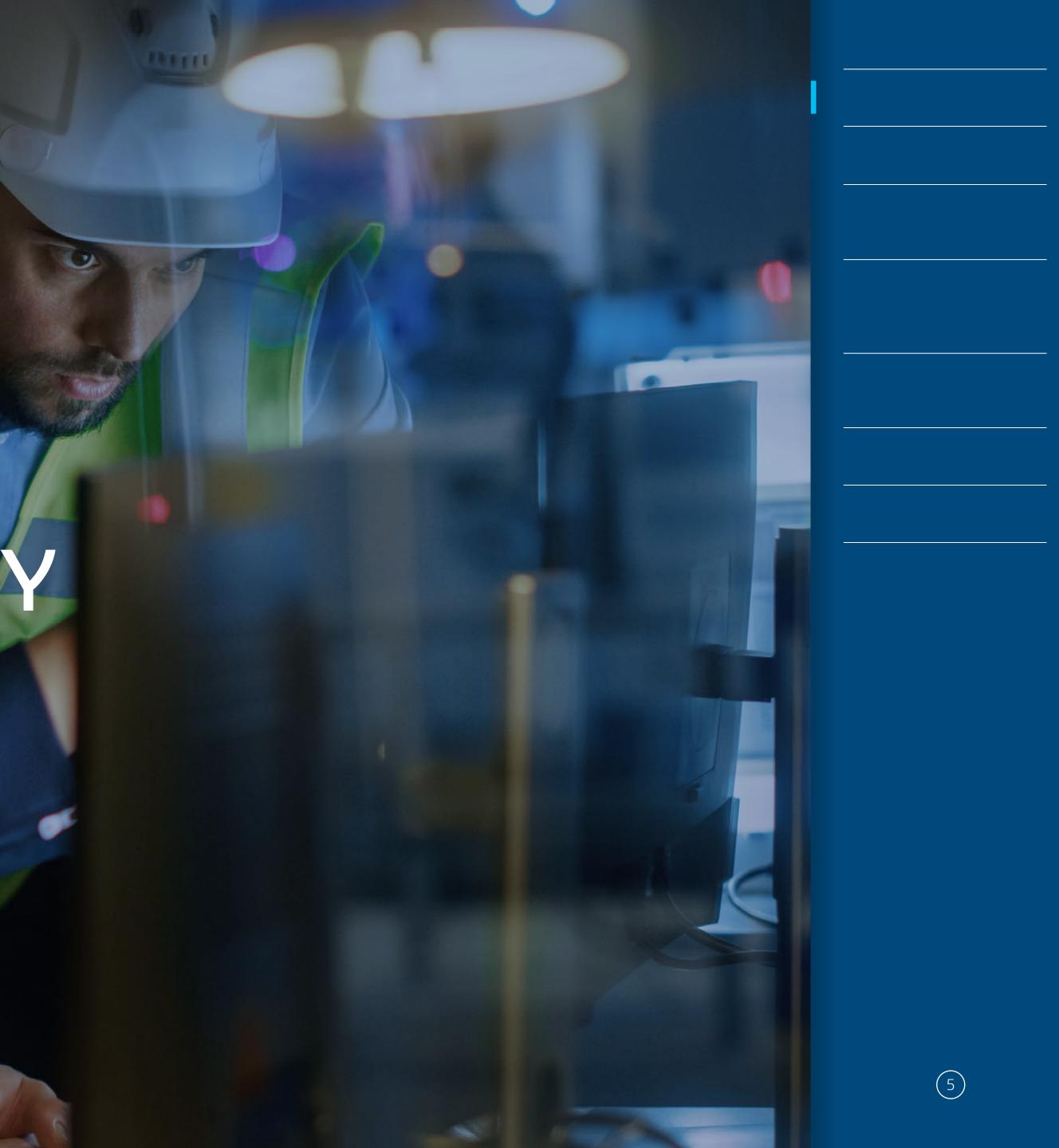
Industrial engineers are responsible for ensuring the most efficient interaction of four pillars of manufacturing which are men, materials, machines and methods, and for enabling innovation and efficiency by planning, simulating, and modeling global operations of those pillars. Almost all objects of our daily life (cars, clothes, food, medicines, etc.) have been produced through a system an industrial engineer has worked on. This makes them vital to the industry and factory of the future.







## EXECUTIVE SUMMARY

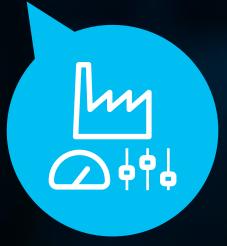


Today's Industrial engineering (IE) is a combination of engineering knowledge and quantitative analysis techniques to support managerial decision-making. It deals with the efficiency with which work is performed by people and machines. Industrial engineers use the analysis and techniques from mathematical, behavioral, and engineering sciences to design, plan, control and manage complex manufacturing and business processes. They improve efficiency of such processes.

In this ebook, we will discover the key concepts of Industrial Engineering discipline, explain why industrial engineers are vital to creating sustainable manufacturing. You will hear from several experts from industry and academic world, who share their views about the skills needed and the missions those professionals have. Finally, we will observe

job outlook data detailing current job openings and several Industrial engineering education programs offered at universities.

Industrial engineers are key jobs for the factory and industry of the future. They will continue to be more and more in-demand because they are skilled in manufacturing systems and processes, in operations, ergonomics and management, and in specifying, predicting and evaluating the performances of the complex manufacturing systems they develop. They are critical to creating more sustainable systems that reduce waste and pollution caused by manufacturing processes for a better productivity and efficiency of manufacturing systems and people.









# INTRODUCTION







The root of the industrial engineering (IE) profession dates back to the Industrial Revolution. An American mechanical engineer, Frederick Taylor (1856 – 1915), is generally credited as being the father of the Industrial Engineering discipline. His studies were based on improving working methods, developing work standards and reduction in time required to carry out the work.

advanced technologies With in Manufacturing, industrial engineers now help business make better decisions and improve processes using different types of principles that increase quality, safety and productivity. They play a key role in contributing to reducing waste by suggesting sustainable innovations for production and logistics.

Their work now includes the development of working methods to increase efficiency and eliminate worker fatigue, the redesign and standardization of manufacturing processes and methods for handling and transporting materials, the development of production planning and control procedures, and production in a more sustainable manner.









The Institute of Industrial and Systems Engineers (IISE), the world's largest professional society dedicated solely to the support of the industrial engineering profession, defines industrial engineering as a domain that "is concerned with the design, improvement and installation of integrated systems of people, materials, information, equipment and energy." They define industrial engineers as "working to make things better."







# KEY BENEFITS OF INDUSTRIAL ENGINEERING





### DID YOU KNOW?

Elon Musk, Tesla CEO: "Designing a manufacturing system is 10 to 100 more effort than designing the product itself."

Industrial Engineering enables innovation and efficiency by planning, simulating, and modeling global operations. Advances technologies allow manufacturing ÍN companies to virtually experience their entire operations from the impact of design to the production. Thanks to IE, manufacturers can extend visualization beyond the product into

manufacturing and operations, simulating manufacturing processes before the physical plant or production line exists. That way, customers can virtually validate value networks, factory layouts, transportation plans, process plans, logistics and workforce plans.

Transforming current production and supply systems, and integrating sustainability objectives, represent key challenges for the manufacturing industry and thus for industrial engineers who manage the complexity of manufacturing systems.





### INDUSTRIAL ENGINEERING TO DESIGN SUSTAINABLE INNOVATIONS





Thanks to the most recent advances in digital technologies, such as collaborative platforms, 3D simulation, virtual twins and industrial operation software, companies are relying on industrial engineers to help them deliver many innovative capabilities into the industrial systems, improve the sustainability of their manufacturing processes and their industrial systems to reduce waste. For example, use of a virtual twin can help minimizing resource consumption and predicting future waste with an accuracy never before achieved. It can support the product life cycle and energy efficiency by collecting information from the design phase to the recycling phase and analyzing context information based on those data.

It's in industrial engineers' hands to create, in a holistic manner, industrial systems that must consider the limited raw materials the planet offers. Overall, they have now to achieve sustainable systems and processes that still meet their economic goals. For that, they may use Lean Management principles. It is a production management approach used by industrial engineering professionals to eliminate waste and improve working conditions for operators. It was designed to increase efficiency on the shop floor, optimize the logistics, production lines, and reducing costs and excessive production (lower defects, eliminate waste, etc.).

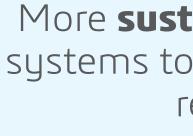


DID YOU KNOW? ' Today, using Lean principles enables Industrial engineering professionals to work smarter, innovate faster, and deliver more value to their customers.

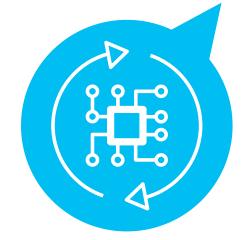




In its Factory of the Future presentation, French health leaders SANOFI mentioned its Framingham (US) digital manufacturing facility, where virtual twin technology is used to optimize remote manufacturing through the use of real-time data capturing and analysis. The whole industrial process is digitalized and paperless and is 80 times more productive than a traditional factory. It can make medicines in less time, for twice the number of patients, and all within a smaller environmental footprint.







**Optimization** of manufacturing processes and business practices

### Key benefits of Industrial Engineering

More **sustainable** industrial systems to reduce waste and resources

Better **productivity** for people



More **innovation** and efficiency by planning and modeling global operations



(14)





# INDUSTRIAL ENGINEER ROLE





#### What do industrial engineers do?

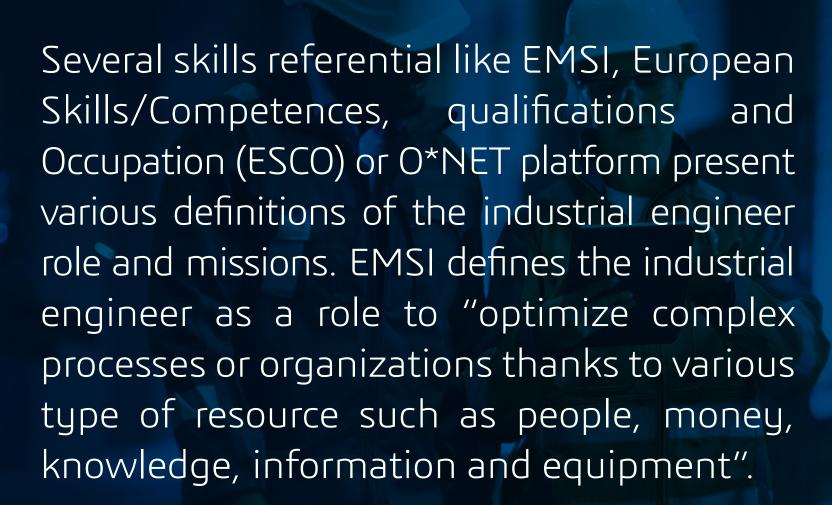
Industrial engineers analyze a system and design a way to improve it. Thus, one of industrial engineers' missions is to eliminate unvalued processes and boost its productivity. They may also improve the working environment of workers within the factory. Industrial engineers may also weigh in on how a company should allocate its limited resources (equipment and workforce) and help to improve manufacturing processes and reduce waste or inefficiencies during the production process. They have to think about a system that combines workers, machinery, materials, information and energy in a holistic manner.

In addition, they might organize space where people evolved by optimizing a travelers journey in an airport, or customers in theme park for example. Industrial engineers also design faster production methods and choose new materials to make longer-lasting products. Depending on the company they work for, they may be called manufacturing engineer, operations engineer, plant engineer, process engineer, etc.









European Commissio

ESCO's definition focuses more on system efficiency saying, "industrial engineers design a vast array of production systems aiming to present efficient and effective solutions. They integrate a varied number of variables such as workers, technology, ergonomics, production flows, and product specifications for the design and implementation of production systems". O\*NET defines the role through the production processes and the way industrial engineers analyze, develop and evaluate methods of production and point out ways to improve them.

include Their focus project areas management, manufacturing, production and distribution, supply chain management, and productivity, methods process engineering, quality measurement and improvement, program management, ergonomics/human factors, strategic planning or change management.

#### O\*NET OnLine







#### Industrial engineers' main skills

O\*NET lists analytics, CAD, industrial and mechanical software, and production and processing as technology skills an industrial engineer should have. Soft skills and abilities an industrial engineer should have include active listening, creative thinking, complex problem solving and deductive reasoning, according to O\*NET. ESCO references engineering design, manufacturing process, production processes, production schedule, safety improvements and control analysis, as essential and optional competences.

An industrial engineer's main skills may differ depending on the company they work for, the discipline they work in, and the missions they have. For example, if they are required to analyze information and use logic to address work-related issues and problems, they

must have analytical thinking and complexproblem solving skills. If the job requires to be careful about details and thorough in completing work tasks, then they must have attention to details skill. If they have to estimate production costs and analyze statistical data and product specifications to determine standards, then they must have production and processing skills.





#### Where do industrial engineers work?

Industrial Engineers work in many types of sectors, like Aerospace, Construction, Electronics, Energy, Entertainment (theme parks), Life Science (pharmaceutical, hospitals), Retail, Shipbuilding and Transportation.



(19)







As an industrial engineer, I need to consider sustainability concepts into my daily work.

Industrial engineers are getting the skills on how to do things more effectively and more efficiently! We are just willing to make the things better!

> CRISTIANO Industrial Engineer

#### In the shoes of Cristiano, Industrial Engineer in Food Industry







#### Meet Cristiano

Cristiano is an industrial engineer working in the food industry. Thanks to advances in technologies, like collaborative platforms, he can virtually experience the entire operations – from the impact of design to determining how to achieve his company's objectives. He sees his systems in 3D as he designs them. He can assess and fine-tune the performance of his production systems and identify bottlenecks early in the planning process and maximize production rates with alternate routings.

Indeed, the food manufacturing industry is one of the largest manufacturing sectors in the United States. Food waste is common across all stages of the food chain. A significant percentage of food is wasted along the supply chain before it reaches the

consumer. Optimizing food waste is one of Cristiano's missions in its production line in order to maximize production sequences while ensuring sustainable practices.

The company he works for uses Dassault Systèmes' DELMIA solutions for process engineering, like assembly simulation engineer or ergonomics specialist roles with which engineers can create and validate assembly/disassembly trajectories or review detailed process planning in the **3DEXPERIENCE** platform, or provide enhanced experience for posturing capabilities and utilize ergonomics data libraries easily.







#### Cristiano's background

Cristiano graduated with a Master's of Science in industrial engineering from the School of Industrial and Systems Engineering (ISYE) of Georgia Institute of Technology (USA). He also earned a Bachelor's of Science degree in industrial engineering from University of Nebraska. He had worked in manufacturing in the Automotive and Telecommunications industries as a process planner for five years, giving him the skills to work for customers from different industries.

Cristiano uses Lean Manufacturing principles to make his company more efficient and productive. For that, he also uses systems thinking in order to optimize the whole system for the delivery of value. It's essential for the teams he collaborates with to have a clear understanding of how all of the pieces work together. In his role, Cristiano must:

#### Cristiano's missions

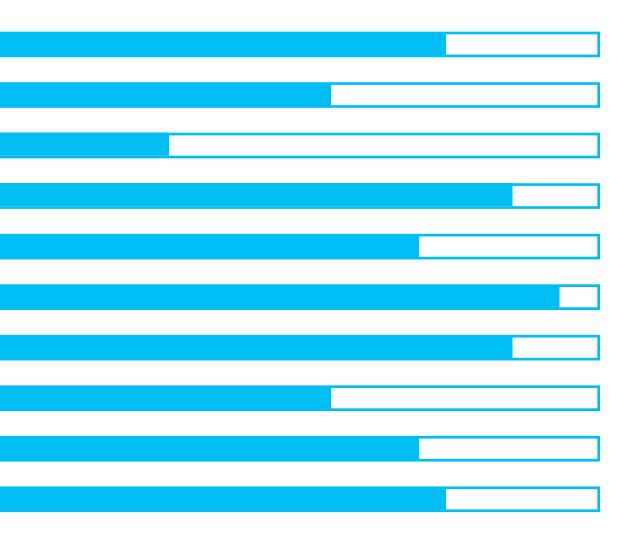
- Analyze multiple production scenarios, in a realistic 3D environment
- Optimize resource positioning thanks to precise 3D simulation
- Define production equipment, line behavior and material flow logic
- Simulate failures of machines, and associate a repair activity and time
- Develop and track KPIs for his production lines
- Lead continuous improvement efforts through statistical analysis
- Perform productivity audits on fabrication and production areas
- Works with outsource manufacturers to ensure product quality, delivery and cost is maintained and on schedule
- Participate to initiation phase of new production lines to assist in design for cost effective manufacturing, layout, labor, and efficiencies





### Cristiano's skills

- Lean manufacturing
- Complex problem solving
- **3D**EXPERIENCE
- Effective communication
- Leadership
- Time Management
- Design Thinking
- Product Development Prototyping
- Creativity and Innovation
- Negotiation







# LEARNING EXPERIENCES FOR INDUSTRIAL ENGINEERING







In 2020, Dassault Systèmes began developing a new portfolio of Learning Experiences that combines domain knowledge and know-how in key Domains of Excellence, to empower the workforce of the future. To learn more about our Learning Paths dedicated to Industrial and Manufacturing Engineering, visit the **3DEXPERIENCE** Edu Space website at https://eduspace.3ds.com.

There are different Learning Paths that contain the domain knowledge related to industrial considerations and applications of the Digital Factory methods. They also encompass the know-how required to perform in an industrial leader role within the **3DEXPERIENCE** platform.

- Factory.



• Be a Manufacturing Process Planner covers the main areas involved in process planning and how it's undertaken in the Digital

• Be a Layout and Flow Simulation Engineer covers the main areas involved in layout

planning and material flow and how it's undertaken in the Digital Factory.

• Be a Digital Factory Leader covers all the knowledge about the Digital Factory, how it works and the economic benefits it offers.

• Be a Digital Lean Yellow Belt covers the main areas involved in Lean management and how to lead actively the Lean transformation for operational teams.





### Those learning materials aim at teaching users how to create, define and simulate a production system to optimize production performance. Upon completion, learners will get the following digital badges:



### There are also some certifications exams associated with these learning paths:

Fundamental of Digital Factory and Fundamentals of Lean Management, plus **3DEXPERIENCE** exams such as **3DEXPERIENCE** Process Engineer (Associate), **3DEXPERIENCE** Work Instructions Author (Associate) and **3DEXPERIENCE** Lean Team Player (Associate) exams. To learn more about our certifications, please go to https://edu.3ds.com/en/be-recognized.

SUBSECTION DASSAULT







## EXPERTS SPEAK

Experts share their views about the evolution of the Industrial Engineering jobs, and the skills needed today and in the future

EMIR





#### **Lionel Roucoules**

Professor at Arts et Métiers Institute of Technology, ENSAM, France, Physical and Digital Systems Engineering Laboratory





Lionel is a professor at the "Arts et Métiers" Institute of Technology (a leading science and technology school in France, and one of French oldest and best engineering schools specializing in mechanical, industrial and energy engineering).

The first curricula about Industrial Engineering have started to be developed 30 years ago. ENSAM opened their master in Industrial Engineering in 1999.

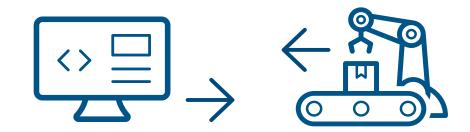
Lionel says students are increasingly interested in industrial organization and to have a global view on how an industry works, thus industrial engineering gets today a stronger interest. He also adds that "any kind of profiles" may attend industrial engineering studies. "Several engineering profiles may compose an industrial engineering team, but for each, one captain will be identified to lead that team."





A new generation of students are also now concerned about environmental impacts and overall, societal concerns, so many universities and engineering schools have adapted their training curricula in that way. According to Lionel, technologies from "Industry 4.0" provide new solutions that help industrial engineers create a better industry for our society. Those technologies can be implemented for Engineering Design, like Virtual and Augmented Reality or Digital Twin, for advanced manufacturing, like additive manufacturing, or for manufacturing systems organization, like e-Obeya, IoT or cobotics. Nevertheless, those technologies must be accepted and used efficiently by the teams in their daily tasks.

Lionel says industrial engineering brings a holistic approach of the industry. This approach must combine human and organization, system and product engineering, information systems, manufacturing system and management.



To conclude, Lionel confirms that the Industrial Engineer role is definitely a key job for the future. "The future of the industry should not be developed with a unique economic point of view but through an interconnection of societal needs and technological advances for a more sustainable world. This is what industrial engineers must provide!"

The future of the industry should be developed through an interconnection of societal needs and technological advances for a more sustainable world. This is what industrial engineers must provide!







#### Alice Steenland Chief Sustainability Officer

There is one big question that comes up when we reference the Paris Agreement and its 2050 net zero carbon emissions target: "Can manufacturing be fueled by renewable clean energy?" The answer represents one half of the challenge for manufacturing industries today.

"The extraction of materials, the transformation of these materials, and distribution of those goods is the other big part of the equation. Historically, there has been a disconnect between the design phase and the Industrial engineering phase and today, there is still a disconnect of between eco-design products (prototyping phase) and the industrial manufacturing of these products," says Alice. Industrial engineers are in charge of thinking about the whole manufacturing engineering process and managing natural resources, thus, they play an important role "not only in trying to get to zero carbon energy sources, but also in the way manufacturing is done today."

Industrial engineers are in charge of thinking about the whole manufacturing engineering process. By integrating climate and circularity into these processes, the industrialization of sustainability is in their hands.





"Dassault Systèmes' solutions already support Industrial engineers in their daily jobs to better arbitrate between products' performance and cost, but now it's possible to add another dimension to this thinking: environmental impact," Alice says. Indeed, virtual twins allow manufacturers to see and manage all the systems virtually, before involving any physical resources, with no risk. That way, industrial engineers can integrate sustainability throughout their industrial operations and businesses more easily, for more sustainable manufacturing. "The software allows every industrial engineer to become an environmental engineer," Alice adds. "The Virtual Twin allows them to come up with ideas, to try and practice, and see how it would happen in the real world with an amazing level of accuracy before they would decide to invest and build a new plant. They are a great support before anticipating changing fundamentally your own systems, processes and machines."

Virtual twins allow industrial engineers to think very disruptively and to fundamentally changing their own systems, processes and machines, without taking any risk.





#### Vera Hummel

Professor Dr-Ing. Industrial Engineering and Logistics, Leader Werk150, ESB Business School Reutlingen-University, Germany

#### Beate Brenner

Dipl.-Ing (FH), Project Leader Digital Engineering, Member of Werk150, ESB Business School Reutlinge-University, Germany

Vera Hummel and Beate Brenner are professors at ESB Business School of Reutlingen University. Industrial Engineering discipline (IE) has been introduced in ESB curricula in 2004, following the request of industrial companies.

Their curricula train future IE professionals capable of designing and optimizing complex production and work systems. "Knowledge elements of Advance Industrial Engineering, i.e. the innovative methods and tools of digital engineering, were integrated into the training of our young future experts with the implementation of the **3DEXPERIENCE** platform in 2016", they say. Student profiles vary from engineering students (Industrial Engineers Bachelor) to Operation Management Master and Digital Industrial Management and Engineering Master profiles.





Vera and Beate confirmed a growing interest for the discipline from their students. They observed the increasing abilities their students now have to think in Systems, which is one of the top skills professionals must have to be successful. The university has drawn some competences requirements for their "Digital Factory and Logistics" lecture. They indeed list five categories: technical and methodical competencies, social and communicative skills, personal competencies, activity and implementation-oriented competencies and cognitive skills. To know more about this competencies model, please refer to the graph on the right:

We observe a growing interest for the Industrial Engineering discipline combined with some increasing abilities to think in Systems.

#### Competence requirements for Digital Factory and Logistics

#### TECHNICAL-METHODICAL COMPETENCES

14.0 System knowledge	C
Technical assistance systems (Cobots)	C
Informational assistance systems	Cl — Tl
Technical Logistics	A
Business Platforms	
Digital business models	C
Innovative Technologies	P
Intelligent products	A
System-methodical procedure	
Interdisciplinary	

Planning and organization skills for "System Factory"

SOCIAL COMMUNICATIVE SKILLS	PERSONAL COMPETENCES	ACTIVITY AND IMPLEMENTATION-ORIENTED COMPETENCES	COGNITIVE SKILLS
operativeness	Willingness to learn	Independent work	Increased reactivity
ommunication	Personal responsibility	Creativity/participation in innovative processes	Technical understanding
ient orientation	Motivation	Ability to design and	Visual perception
ninking in partnership	Reliability	optimize complex systems	Conclusive thinking
pility to work in a am	Personal responsibility	Decision-making ability	Spatial imagination
onscientiousness	Competence in complex systems	Stress resistance	Monitoring and control tasks
oblem-solving ability	Holistic thinking	Commitment	
daptability	Open to new ideas	Single-mindness	
	Stress resistance	Working under high mental stress	
	Self assertiveness		



Source: Marc Guldin's thesis: Hochschule Reutlingen, Departement of Industrial Engineering and Logistics





According to Vera and Beate, in today's factories, industrial engineers take over technology and system integrators' missions, knowledge managers and advisors on best practices. Their role is to optimize process planning and humane work system design with the help of classical (e.g. time determination procedures and ergonomic considerations) and innovative methods and tools (e.g. sensor systems for time determination and work plan provision via smart devices). For example, new innovative technologies do influence the operations the industrial engineers are involved in, like business platforms, Augmented or Virtual Reality, collaborative platform, as well as physical production such as cobots, additive manufacturing or sensor systems. However, both observed that the role will still continue to evolve in the future thanks to the use of artificial intelligence and probabilistic methods. "Production system design and optimization will take place dynamically, in real-time and with integrated engineering in networked digital and physical factories (Virtual Twin) using artificial intelligence and probabilistic methods," they said.

To conclude, they say that industrial engineer plays a role in sustainable innovations development. "Due to the increasing ecosystems (customers, environment, company and supplier) industrial engineers must work on, sustainable innovation becomes part of their future work."

> In today's factories, industrial engineers role is to optimize process planning and humane work system design.





#### Loic Painvin

Digital and Robotics Innovation manager, Faurecia, France (Engineering and Production for Automotive industry)

Loic says new processes and new technologies are implemented under the lead of Industrial Engineering professionals: digital transformation, continuous improvement, industrialization and change management are key elements to the factory of the future and for industrial engineers though.

Industrial engineers' missions are to lead, validate the machines and qualify equipment. They also orchestrate the transitioning of software, IT and traditional processes, as well as to design processes. According to Loic, improving industrial processes is possible through the Industry 4.0 because the data is collected and used in real time. For example, simulation is a powerful tool used by industrial engineers to validate the processes they need to implement. "However, onsite experience remains absolutely necessary to evaluate the constraints that are not visible through simulation". They also use Design for Product and Design for Manufacturing (DfMA) quite soon in the lifecycle to anticipate all impacts created by the new processes. Industrial engineer roles require several different skills. "They have accountability and leadership and project management to orchestrate all the activities in the manufacturing process (like planning and budget, etc.), plus some mechanics and electronics knowledge. Active listening, open-mindedness, complex problem solving, are also the necessary soft skills", says Loic.

> The Industrial Engineering professionals are key to implement new processes and conduct change management. They contribute to create sustainable solutions thanks to the innovations they propose.





Faurecia is incorporating more and more digital as part of its transformation. "Our talents need to be open to new solutions, like cloud storage, cloud computing and have sensor or vision knowledge in order they can anticipate the best integration possible of our solutions". Today's industrial engineering students are comfortable with all those digital technologies, so they can easily practice them, while keeping basic knowledge, plus they remain open to acquire new skills. In this regards, Faurecia created an Academy more than six years ago to train their employees and upskill people on digital technologies, whatever their profiles are.

At Faurecia, several job titles designate industrial engineering professionals.

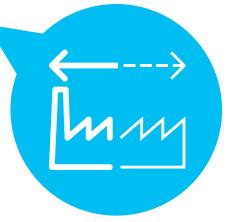
• In R&D center, "program manufacturing leader" or "product and process manufacturing leader" plan the production line, sequence and tooling. They mainly focus on the long-term vision to design, define processes and the viability of products, Loic explains. They also improve the equipment, logistics stream (between plants) and manage (process) supplies. We can also found "process specialist" and "process expert" in charge of specific technology to support project and plant in their usage and installation.

- R&D center.
- drives the methodology.

Lastly, Loic points out the upcoming regulation for manufacturers to introduce more visibility into their products' sourcing and their production processes. Sustainable manufacturing has indeed become critical for organizations in securing a competitive advantage and bringing a benefit to their final product. "Today, all industries are involved in trying to reduce their environmental impact, and sustainable manufacturing needs to be part of the processes", Loic concludes.

• In the plant, "industrial plant team leader" and "digital transformation expert" lead the digital transformation. They manage the operations, while leading day-to-day work, as well as integration of new equipment or layouts, and also support the

• Other senior positions of industrial engineer do exist, like "lean manufacturing leader" role that



Industrial engineers are key jobs for the future, mainly because they implement new processes, understand and support the changes, bring sustainability into the manufacturing processes.





# Darko Sucic

Industry Process Consultant and Managing Director, Dassault Systèmes

Darko has seen the evolution of the manufacturing jobs evolved over the time. He says that digital factory models brought many changes to the industry. In the coming years, Darko considers a growing digitalization expansion. In addition, he shares his vision of the technologies influencing the industrial engineer role. According to Darko, "The manufacturing digitalization is to build and maintain factory digital twins to study the behavior of manufacturing processes before real factories are constructed or modified. We expect that the digitalization, Industry 4.0 and its technologies will have a cross-industry impact on factory in the future that will still need to be planned and simulated by industrial engineers." The main and the most impacting transformation of the job is "the intensive usage of simulation, validation and aggregated real production data for all manufacturing aspects," Darko says.

Industrial engineers should consider factory processes in a holistic manner: having the ability to understand the factory as a system of systems.





In addition, thanks to the success of the digital factory, "industrial engineering jobs evolved from using paper and pencil, through using calculation tables like Excel to now building virtual factory models based on so called PPR models (Product-Process-Resource) that can be directly simulated." For this, Darko says the **3DEXPERIENCE** platform, as a collaborative platform, provides all the necessary apps to build the virtual twins of factories that will help to introduce innovative manufacturing processes beforehand.

The further digitalization, particularly in the context of virtual twin experiences, will bring the manufacturing planning in early phases before Start of the Production (SOP) closer to the Industrial Manufacturing Planning in the factories. The difference between planning in virtual and execution of the planning in real will gradually disappear, he adds.

According to Darko, industrial engineers should be skilled enough to consider "factory processes in more holistic way and have the ability to understand the factory as a system of systems, combining the knowledge of part fabrication and assembly domains with logistics, efficiency and maintenance".

Industrial engineers play a vital role in enabling the sustainability challenges we are facing today. "Sustainability means to consider the workforce, the environment and profitability of the value network from suppliers to customers in a circular economy. As a result, it's in industrial engineers' hands to "evaluate and select the right technology and the best provider for the sustainable manufacturing in the future", he concludes.

It's in industrial engineers' hands to evaluate and select the right technology and the best provider for enabling a sustainable manufacturing in the future.





# JOB OUTLOOK







# Different namings

As previously explained, many industrial engineering professionals do not necessarily have Industrial Engineer in their job title. Indeed, from one company to another, an industrial engineer may have a different naming. Such engineers will focus on production flow if he/she works in food industry, on planning for manufacturing industry or time and space optimization if he/she works in hospitals, theme parks or even airports.

O\*NET lists related job titles as: continuous improvement engineer, facilities engineer, operations engineer, plant engineer, process engineer, project engineer, quality engineer, research and development Engineer.

ESCO mentioned other job names such as manufacturing engineer, production engineer, industrial engineering expert, engineer, industrial industrial waste technology engineer, industrial technology engineering adviser, industrial technology engineering expert, industrial engineering consultant, or industrial engineering specialist.







# Workforce

In January 2022, there were almost 4 million worldwide people the among LinkedIn members with "Industrial engineer" in either their job description or their title.

Growth in **healthcare** and **changes in** how healthcare is delivered will create demand for industrial engineers in firms in Professional, Scientific and Consulting services.



# Job postings

According to the US Bureau of Labor Statistics, overall projected employment of industrial engineers in the US is expected to grow by 14% by 2030. Occupations represented 292,000 jobs in 2020 according to the Bureau and is projected to reach 332,000. About 23,300 openings for industrial engineers are projected each year, on average, over the decade 2020 - 2030.

In January 2022, LinkedIn referred more than 100,000 job offerings for industrial engineer role, in companies like Boeing, FedEx, General Motors, Amazon, Michelin, from several areas like South America, Central Europe and Asia.





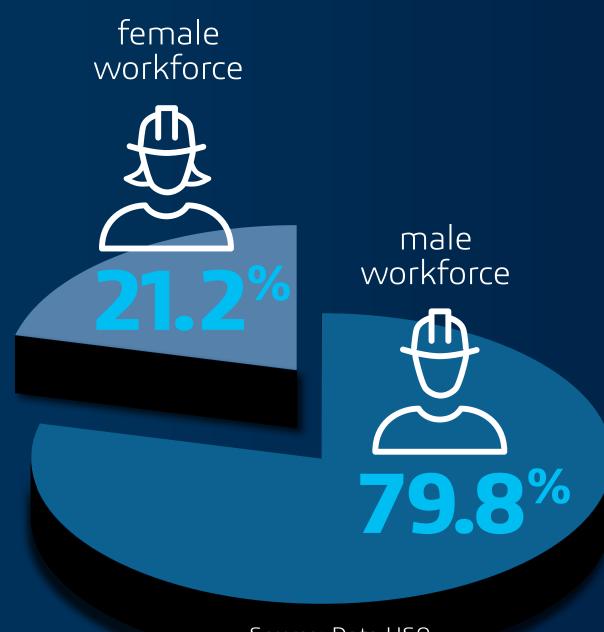
# Key figures

# people

worked as industrial engineers in the US



Source: US Bureau of Labor Statistics



Source: Data USA

# According to the US Bureau of Labor Statistics



women were working in Industrial Engineering in 2018 — a **82%** increase over a 5-year period (2014 - 2018)





# Education

Programs related to industrial engineering and logistics systems focus on developing students' abilities to analyze and design systems that integrate technical, economic or even social factors in manufacturing, services, social and government organizations. Those programs lead to various professional opportunities in the Manufacturing and logistics industry, but also in healthcare services, research and development, public service enterprises, and business corporations.

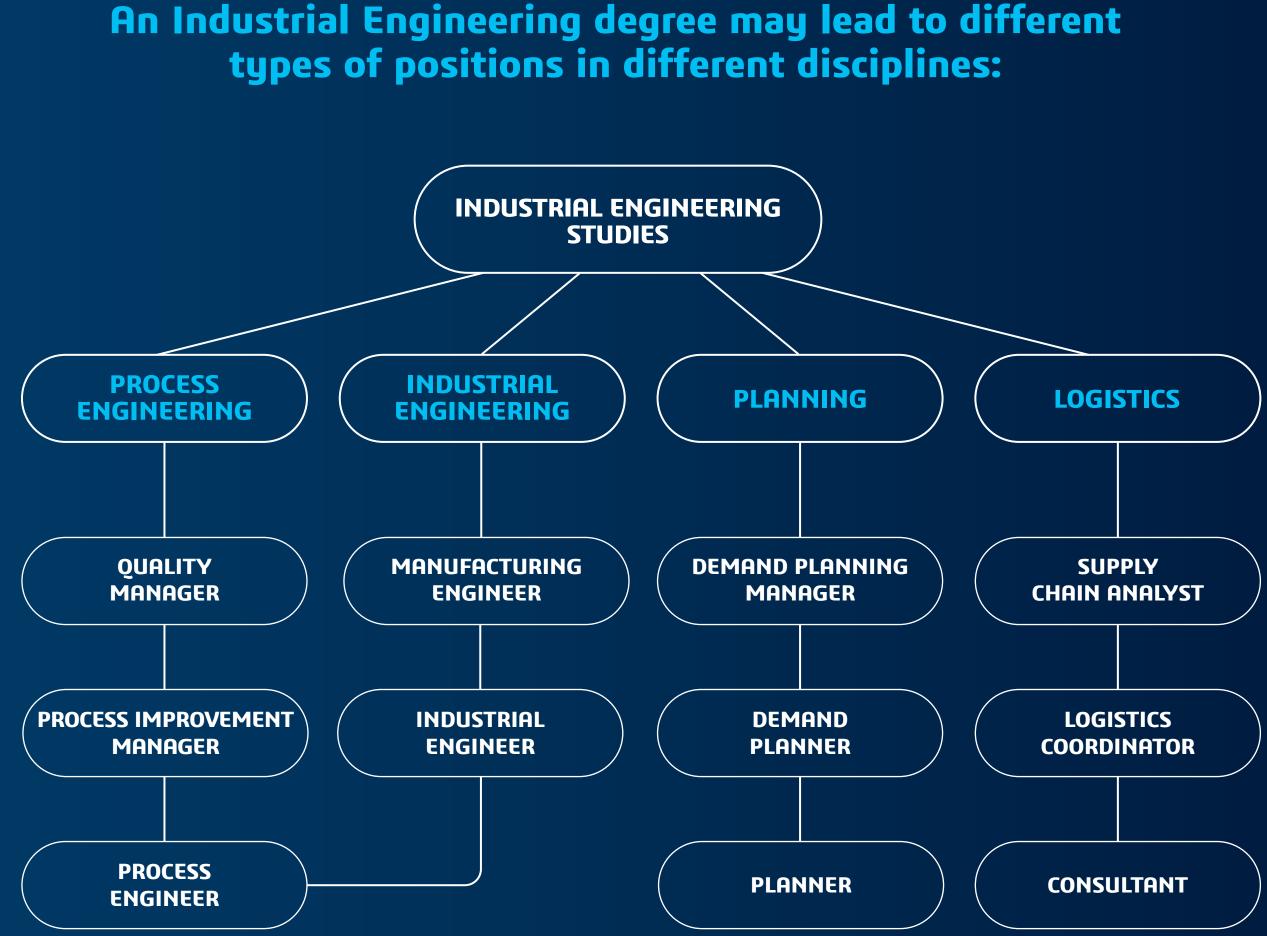
A bachelor's degree in industrial engineering is generally the minimum educational requirement to become an Industrial Engineering professional. Hundreds of bachelor or master's degrees in Industrial engineering exist around the word, like a Bachelor of Agroindustrial Engineering from IPB University in Indonesia, a BSc in Industrial and Systems Engineering from Qatar University, or a B.Eng. Industrial Engineering and Logistics Systems (IE) from Sirindhorn International Institute of Technology (Thammasat University) in Thailand.

The University of Grenoble in France has developed a master called "Sustainable Industrial Engineering," which addresses the issue of industrial sustainability using environmental approaches associated with social, societal and economical ones.





Among the LinkedIn members, many industrial engineers list in their educational experience having degrees (Master's) in Manufacturing engineering, Industrial engineering, Industrial Management or Production Management. Most of the Industrial Engineering programs include mathematics, mechanical engineering subjects, manufacturing processes, manufacturing techniques, process analysis, operations management, and basic business subjects.



Source: https://www.zippia.com/industrial-engineering-major/





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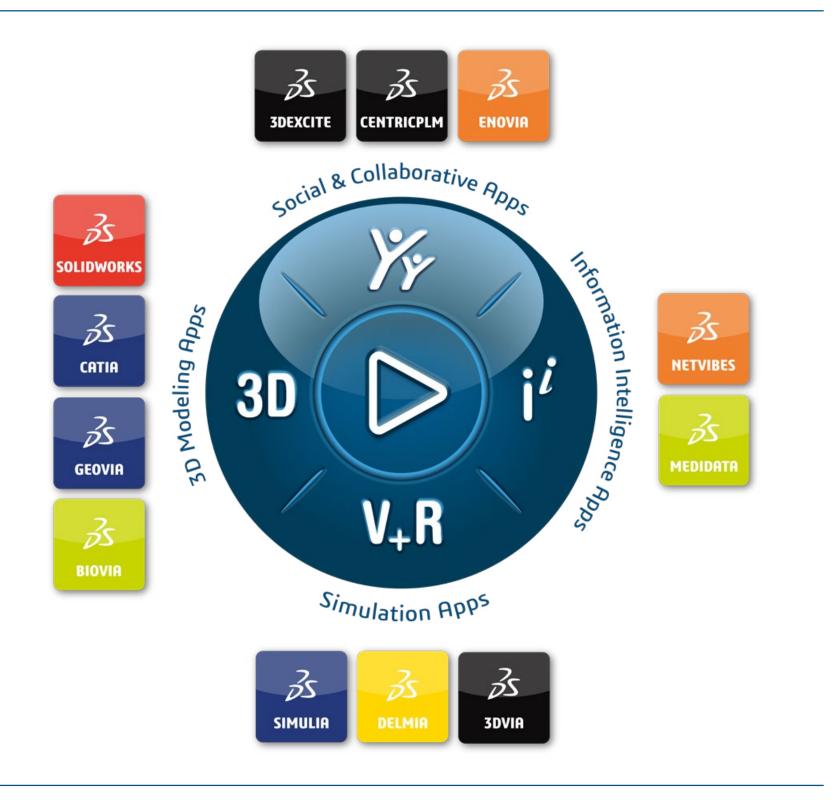
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