TRANSFORMATION OF MANUFACTURING:

Embracing Digital and Green Skills

CONTENTS

FOREWORD

As digital transformation continues to reshape the manufacturing industry, the use of advanced and complex technologies is becoming increasingly prevalent. To realise the full potential of these technologies, it is vital for the industry to embrace greater collaboration between intelligent systems and a well-trained workforce. By doing so, manufacturers can ensure they have the skills and resources needed to capitalise on the benefits of these complex technologies and remain competitive in a rapidly evolving landscape.

This report aims to shed light on the emergence of new skills and professional profiles that are driving the digital and green transformation of industries. In particular we will focus on the skills gap in Manufacturing, with a special emphasis on the Machine Tool industry. Our report identifies the digital and green skills in demand and explains how education, businesses and training providers can help mitigate the gap. We also analyse the gradual development of new roles that will complement the traditional roles in the Machine Tool industry, following the digital and green transformation.

To produce this report, we have drawn up studies and reports provided by the CECIMO National Associations and desk research on the current skills and knowledge that will be essential for professionals working in this field in the future.

We would like to thank AFM Cluster for Advanced and Digital Manufacturing; AGORIA: Federation of the Technology Industry; EVOLIS: French Association for Industrial Equipment and Machinery ; MTA: Manufacturing Technologies Association; Technology Industries of Finland; UCIMU - SISTEMI PER PRODURRE: Italian Association of Manufacturers of Machine Tools, Robots, Automation Systems and Ancillary Products; and VDW: German Machine Tool Builders' Association for generously providing their valuable inputs and research papers, which contributed greatly to the development of this report.

We hope this report will be a valuable resource for those seeking to understand the changing nature of advanced manufacturing and the skills needed to thrive in the digital and green economy.

Filip Geerts
CECIMO Director General

1

STATE OF PLAY

The shift towards sustainable practices and digital solutions is becoming increasingly important in all sectors, and advanced manufacturing is no exception. Currently, **more than three-quarters of companies in the EU face difficulties in finding the necessary skilled workforce since about 44% of adults undertake training on a regular basis**, according to Eurostat figures[1]. To date, machine tools, robots and automation systems have gone from being simple mechanical tools to true mechatronic systems (with the integration of mechanical, electrical, and computer engineering), thus encouraging the interaction between mechanics, information technology and electronics.

The digital and green transitions are two inevitably interlinked megatrends as the advancement and investment in digital technologies establish the necessary groundwork for the green transition. Utilizing innovative digital techniques reduces the excessive use of natural resources, thus enabling manufacturing sustainability. On this note, digitalisation, environmental sustainability/greenification, automation/mechatronic systems and robotics create a picture of what a 2030 advanced manufacturing workforce will look like and, importantly, what will need to be done to secure the workforce possess the required skills for the digital and green transition of manufacturing.

The AFM study[2] suggests that the most profound change will occur in employees' responsibilities and that jobs will tend to change rather than disappear. To stay ahead in the advanced technologies race, businesses compete to recruit the best-qualified technical engineers and data experts with the latest skills in designing, programming, engineering, manufacturing and utilising machine tools. In other words, workers' skills are now more than ever a fundamental element of today's industrial competitiveness.

2

DUAL SHORTAGE: SKILLS AND LABOUR

Machine Tools manufacturers are going through a period of transformation adjusting their processes to new technologies and business models to enhance their performance and competitiveness. Such a transformation cannot happen without the critical contribution of the workforce.

Nevertheless, manufacturers are facing two main challenges:
1) Shortage of required technical skills across the production line
2) Immediate labour shortage.

According to the Make UK Executive Survey, 2022[3] results showed that the British advanced manufacturing sector is facing a tight labour market. Around 20% of the labour market is defined as "economically inactive", thus shrinking the labour pool notably by older people (aged 50-70 years old) due to early retirement. More than half of the UK's manufacturers experience the labour shortage as a warning sign.

On the other hand, Germany does not experience such a severe issue with skills shortages and education mismatch but rather with the labour shortage due to the acute problem of demographic changes and the limited attractiveness of the machine tool sector. According to the VDW survey[4] results, the number of job opportunities in engineering is rising significantly faster compared to the overall increase in employment, with 20% versus 1.3%.

Overall the machine tool industries experience major experts' shortages in the following fields: Mechatronics Technicians, Automation Technology, Metal Cutting, Mechanical and Industrial Engineering, and Electrical Engineering.

For the Machine Tool industries, some of the most difficult professional profiles to recruit are: Service Engineers, Design Engineers, Computerised Numerical Control (CNC) Operators and Machinists, as well as Software Development Engineers and Mechanical Engineers. Many employers regard technical skills (machinery), digital skills (software and programming) and Quality Assurance (QA) and Quality Control (QC) as critical competencies that require upskilling among current employees.

The main reason for this shortage is the small number of applicants and the mismatch between the supply and the demand in the industrial market. In other words, there is a limited labour pool with the future-required skills, which is interlinked with the fact that Machine Tools is a very niche area of manufacturing, where the skills requirements are quite specialised to their businesses. Therefore, the specialised nature of work constitutes a labour pool limited geographically because the qualified staff typically is situated in central and high-demand locations.

Figure1: Machine Tool Roles in which major skills gaps exist in the UK [4]
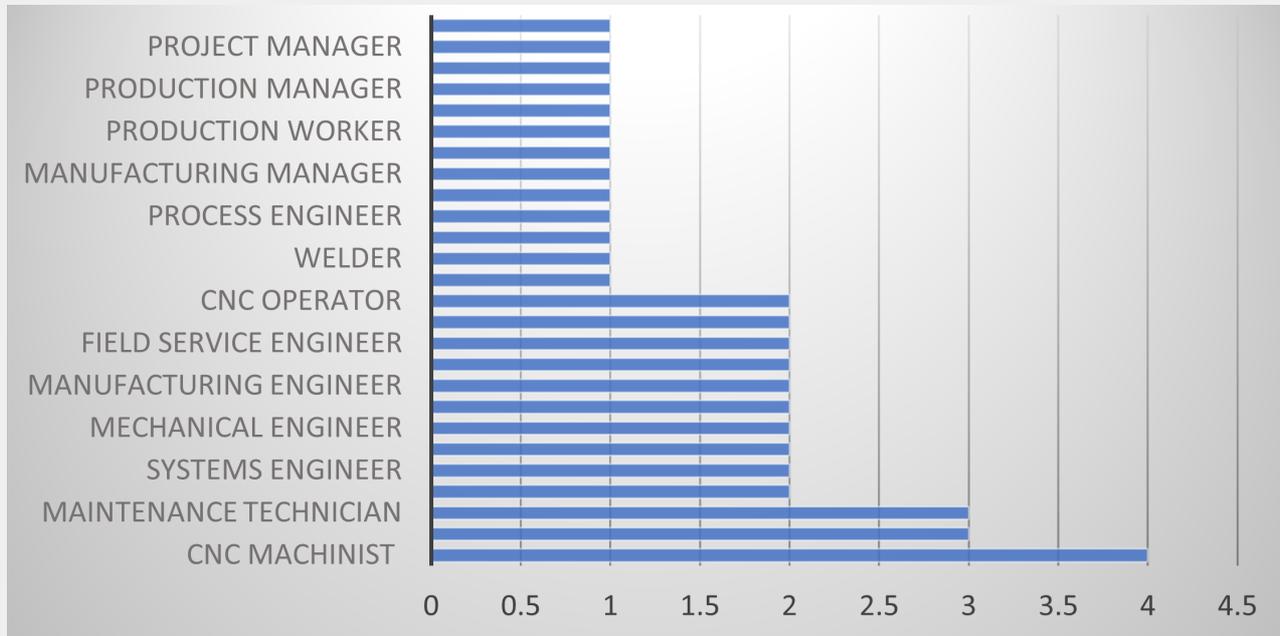
Source[5]: Pye Tait Consulting Research, 2020

Furthermore, the skills gap remains persistent among traditional professional profiles in machine tools manufacturing. For instance, EVOLIS, the French Association for Industrial Equipment and Machinery, has highlighted that most of its members find it difficult to recruit Electrical/Electronic and Computer Engineers, Electrotechnicians, Mechanical Fitters and Technical Sales Executives. The problem stems from the fact that young people are often unaware of the benefits that the machine tool sector can offer, leading to lack of motivation and undervaluation of the industry.[6]

According to the UCIMU Study Centre[7], 67.7% of Italian companies indicated the Mechanical Fitter/Assembler (fitting and assembling metal parts to fabricate machines) as the most sought-after professional profile for machine tools production with a high level of recruitment difficulty. Around 42% of enterprises are in need of Service Technicians/Relocators and Service Technicians/Installers to install, test and maintain machines in the service department.

However, in Italy, not all companies consider hiring new employees crucially important for their business growth but rather emphasise upskilling and retraining their existing workforce to keep up with changing technical requirements and retain skilled talent in the company for an extended period. In the near future, companies seeking to hire new professional profiles within the Machine Tool industries are likely to prioritise Designers for the mechanical engineering department, who can create new machines to enhance efficiency, as well as Software Developers for the electrical engineering department, who can develop software and programming for advanced automation and control. The availability of skilled workers is crucial if companies are to remain competitive in the highly specialised machine tool industry.

3

EMERGING SKILLS

Innovative technologies need qualified personnel, who in turn must possess the suitable qualifications to maximise the equipment efficiency, enable predictive maintenance and lower the production costs, waste and time through an advanced process control. To that end, the deployment of digital technologies will allow the adoption of green innovations, making the manufacturing fit for net-zero and simultaneously ranking digital and green skills among the most needed.

3.1 Digital Skills

Around half of the manufacturers perceive digitisation as a trend that is changing jobs and skills needs for their business.[3] The most significant hurdle to the adoption of Industrial Digital Technologies (IDTs) is insufficient proficiency in digital skills. Overcoming this obstacle would allow manufacturers to reap more of the benefits offered by digitalised workplaces.[8]

As advanced manufacturers continue to adopt new digital technologies and automate their factories, the demand for software skills, cyber security skills, data analyses and programming skills is increasing. For example, employees are no longer part of a repetitive assembly line and are required to program CNC machines, thus controlling the entire production process.

Digital Profiles Required for Jobs in Machine Tools

The digital transformation of machine tool industries will gradually develop new professional profiles, complementary to the traditional roles. More than 50% of Italian Machine Tool industries indicated that **Operational Technology Performer** and **Web Security Expert** will be considered fundamental as well as difficult to recruit with the right skills, needed for the digital transition of manufacturing industries.

The role of an Operational Technology Performer will entail ensuring that the machines and processes used in the manufacturing process are functioning optimally and efficiently. In addition to maintaining the systems, the Operational Technology Performer would also be responsible for ensuring that the machines and processes are operating in compliance with relevant safety and regulatory requirements.

The profile of a Web Security Expert is accountable for identifying and mitigating potential security threats on organizations' systems, networks, and devices. The Web Security Expert would need to have a deep understanding of the specific security risks and challenges associated with the industry, ensuring that the organization's systems and applications meet the requirements of relevant security frameworks and standards.

Other emerging professional figures that will be also sought-after are **Analytics Developer**, **Data Scientist**, **Data Analyst**, **IT Specialist** and **Internet of Things (IoT) Specialists**, who develop, manage, and monitor IoT devices and systems. The Analytics Developer will be responsible for the digital technology, defining algorithms, and analysing and monitoring sets of big data by using statistics.

A **Data Scientist** and a **Data Analyst** will be in charge of the inspection, validation, extraction and interpretation of data collection for the development of predictive models. Their role will also entail providing reliable data; using different algorithms, IT tools and data visualisation for carrying out statistical analysis; and managing the application of machine learning, deep learning and digital electronics.

IT Specialists along with Technicians, specializing in hardware development, will be needed in developing computer hardware such as motherboards and microprocessors. The Computer Engineers will analyse, design and develop Information and Communication Technology (ICT) assets and IT services; adopt preventive and corrective maintenance methodologies to meet technological surveillance; and draw up security policies and technologies for networks and information systems, developing computer systems.

An **IoT Specialist** in Machine Tools manufacturing has a critical role in designing and implementing IoT-enabled solutions to improve the efficiency, quality, and performance of machine tools. The IoT Specialist would work closely with engineers and other professionals in the manufacturing process to integrate IoT technologies into the design and functionality of machine tools. This may involve developing sensors and other connected devices. IoT Specialists would be responsible for analysing data generated by these devices to identify areas where maintenance or repairs are needed, predict when parts will need to be replaced, and optimise the use of energy and other resources.

Figure 2: Digital Professional Profiles
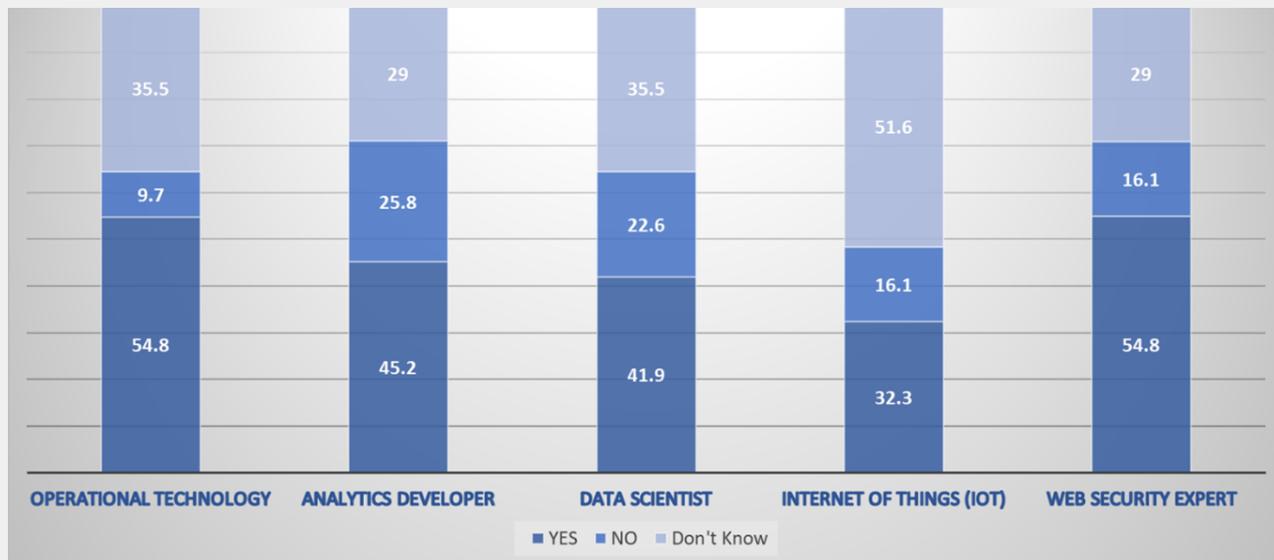
Source [6]: UCIMU Academy Survey and UCIMU Study Center (2023), "Il fabbisogno di figure e di competenzeprofessionali"

3.2 Green skills

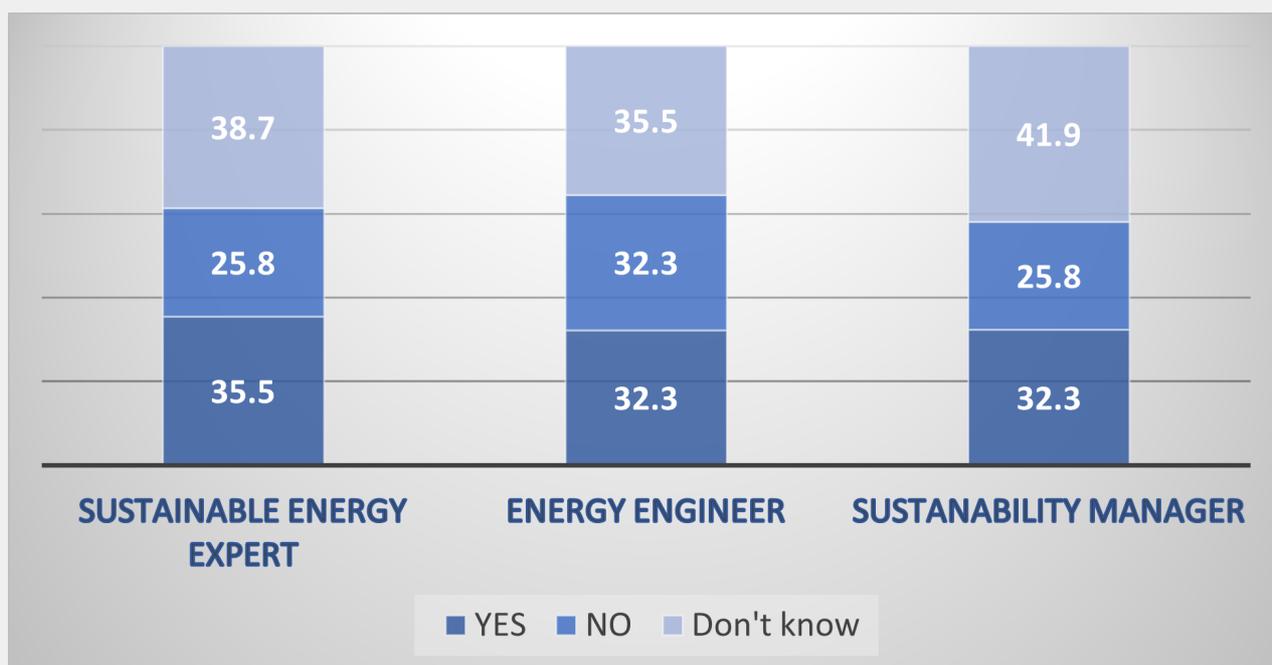Despite the push for a greener economy, there is not yet a universally accepted definition of what are the professional characteristics needed for a "green job." European Centre for the Development of Vocational Training (Cedefop) defines green skills as "**the knowledge, abilities, values and attitudes needed to live in, develop and support a sustainable and resource-efficient society**[6]." Therefore, green jobs require green skills.

In manufacturing, developing green skills can significantly contribute to the green transition of industries by reducing the environmental impact of the operational and production processes, including energy consumption, waste generation, and greenhouse gas emissions. According to Make UK Executive Survey 2022, 37% of British advanced manufacturers agreed that greenification is a factor in changing skills needs.

In terms of reasons to incorporate green skills, the machine tools industry does not differ from the other sectors. It can help companies to meet sustainability goals comply with environmental regulations and improve their reputations. Examples of green skills in the machine tool industry include knowledge of environmentally friendly materials, energy efficiency and conservation, waste management, sustainable design, and environmental compliance. These skills can improve the manufacturing process of the machine tool industry and create a more environmentally responsible manufacturing sector.

Although for the whole machine tool industry it is still uncertain which new professional profiles are needed to facilitate the green transition, the survey conducted by UCIMU Study Center suggests that profiles such as **Sustainable Energy Expert**, **Energy Engineer** and **Sustainability Manager** might be soon in demand in the machine tools area.

Figure 3: Green Professional Profiles

	YES	NO	Don't know
SUSTAINABLE ENERGY EXPERT	35.5	25.8	38.7
ENERGY ENGINEER	32.3	32.3	35.5
SUSTANABILITY MANAGER	32.3	25.8	41.9

Source [6]: UCIMU Academy Survey and UCIMU Study Center (2023), "Il fabbisogno di figure e di competenzeprofessionali"

A **Sustainable Energy Expert** can play a crucial role in ensuring that the manufacturing process of the machine tools is energy-efficient and sustainable. This profession entails developing and implementing sustainable energy strategies, conducting energy audits to reduce energy consumption, implementing renewable energy solutions and monitoring energy usage. Moreover, the expert would have to ensure that the manufacturing process complies with all relevant sustainability regulations, such as emissions limits and energy efficiency standards and identify opportunities for innovation. On this note, the role requires proficiency in energy systems, renewable energy technologies, energy efficiency as well as analytical skills to conduct energy audits.

The role of the **Energy Engineer** in Machine Tools manufacturing is to optimize the energy consumption of the production process and reduce the carbon footprint of the manufacturing plant. This can involve designing and implementing energy-efficient processes for manufacturing machine tools, evaluating energy performance, implementing energy-saving technologies and providing training and education to staff on energy efficiency. On this note, the professional must have a good understanding of mechanical and electrical engineering principles, thermodynamics, energy systems, and energy-efficient technologies.

Lastly, a **Sustainability Manager** bears responsibility for overseeing the development and implementation of sustainable practices within the manufacturing process, coordinating sustainability initiatives and monitoring sustainability performance. Furthermore, a Sustainability Manager will have to assess and mitigate environmental risks during the production process and conduct sustainability audits, maximizing efficiency and profitability. This profession of a Sustainable Manager requires knowledge of sustainability principles, including environmental and social sustainability, as well as sustainable practices in areas such as energy, waste management, and water conservation.

3.3 Other Future Skills

Apart from the digital and green jobs, machine tool industries should also embrace the world of robotics for reinforced efficiency, consistency, flexibility and precision of the production process. UCIMU Study Center pointed out that around 67.7% of enterprises consider a **Robotics Specialist** as a highly significant professional profile for the near future to manufacture high-quality tools with a high degree of accuracy, productivity and safety. The role of the Robotics Specialist reflects upon developing and testing new robotic systems and applications that can be used to automate the production process; designing and implementing robotic work cells to optimise specific manufacturing tasks; and conducting safe training sessions for employees.

In addition, an overwhelming majority of European enterprises consider **Technicians for Automation and Mechatronic Systems** as game-changers in ensuring that the automation system is functioning correctly and safely by reducing downtime and improving productivity. Specifically, an Automation or Mechatronic Technician can install and maintain the automation system used in machine tools; identify and repair the malfunction; guarantee workers' safety; and train machine operators. The Technician will have to possess good electrical knowledge (electrical circuits, wiring diagrams, and electrical codes) to work with mechatronic systems, mechanical knowledge as well as computer programming to operate mechatronic systems.

4

FOCUS AREAS

Education is a key driver in building the new generation of skilled employees in manufacturing, especially for the transition towards industrial digital and green solutions. Nevertheless, teaching and training programmes struggle to keep pace with the rapid technological advancements and the evolving needs of the labour market. Consequently, workers face limited opportunities to acquire the necessary competencies for their jobs, hindering their professional growth and impeding progress towards sustainable and efficient production processes. To bridge the skills gap and ensure the workforce is prepared for future challenges, we have identified specific focus areas that must be by both enterprises and educational institutes.

Actions for Enterprises

1. Increase the number of in-company training opportunities such as apprenticeships to help workers acquire the necessary skills for jobs in the manufacturing sector. Apprenticeships are built on a contract and remuneration makes it an attractive option for adults who seek to obtain technical digital and green qualifications.

2. Inform young people about career opportunities in the sector, particularly high school students, to tackle demographic changes and retain the existing skilled workforce.

3. Intensify the recruitment of young people into the manufacturing industry.

4. Establish learning opportunities and targeted upskilling/reskilling programs within the workplace with the assistance of the EU and benefit from the different training programmes initiated by EU-funded projects (Skills.move platform, AM Qualification System etc.).

5. Adopt clear equality policies within the workplace to attract more women into advanced manufacturing and retain them.

Actions for Educational Institutes

1. Develop tailored courses and modernised training facilities to offer the right skill sets that can adapt to the new dynamic of manufacturing.

2. Provide work-based learning options, including apprenticeships to mitigate skill mismatches in times of rapid technological change.

3. Offer sector-specific courses and specialised technical training to meet the needs for digital skills such as Mobile Learning in Smart Factories (MLS) platform as a learning tool in education and training for young professionals in mechanical engineering or technical high schools.

4. Establish greater coordination and collaboration between workers, educational institutions, and industries to encourage the uptake of mechanical engineering in university courses through innovative teaching methods such as gamification.

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CECIMO is the European Association of the Machine Tool Industries and related Manufacturing Technologies. We bring together **15** national associations of machine tool builders, which represent approximately **1500** industrial enterprises in Europe (EU + UK+ EFTA + Türkiye), over **80%** of which are SMEs. CECIMO covers about **97%** of the total machine tool production in Europe and about **1/3** worldwide. It accounts for approximately **150,000** employees and a turnover of around **25.1** billion euros in 2022. More than three quarters of CECIMO production is shipped abroad, whereas half of it is exported outside Europe.

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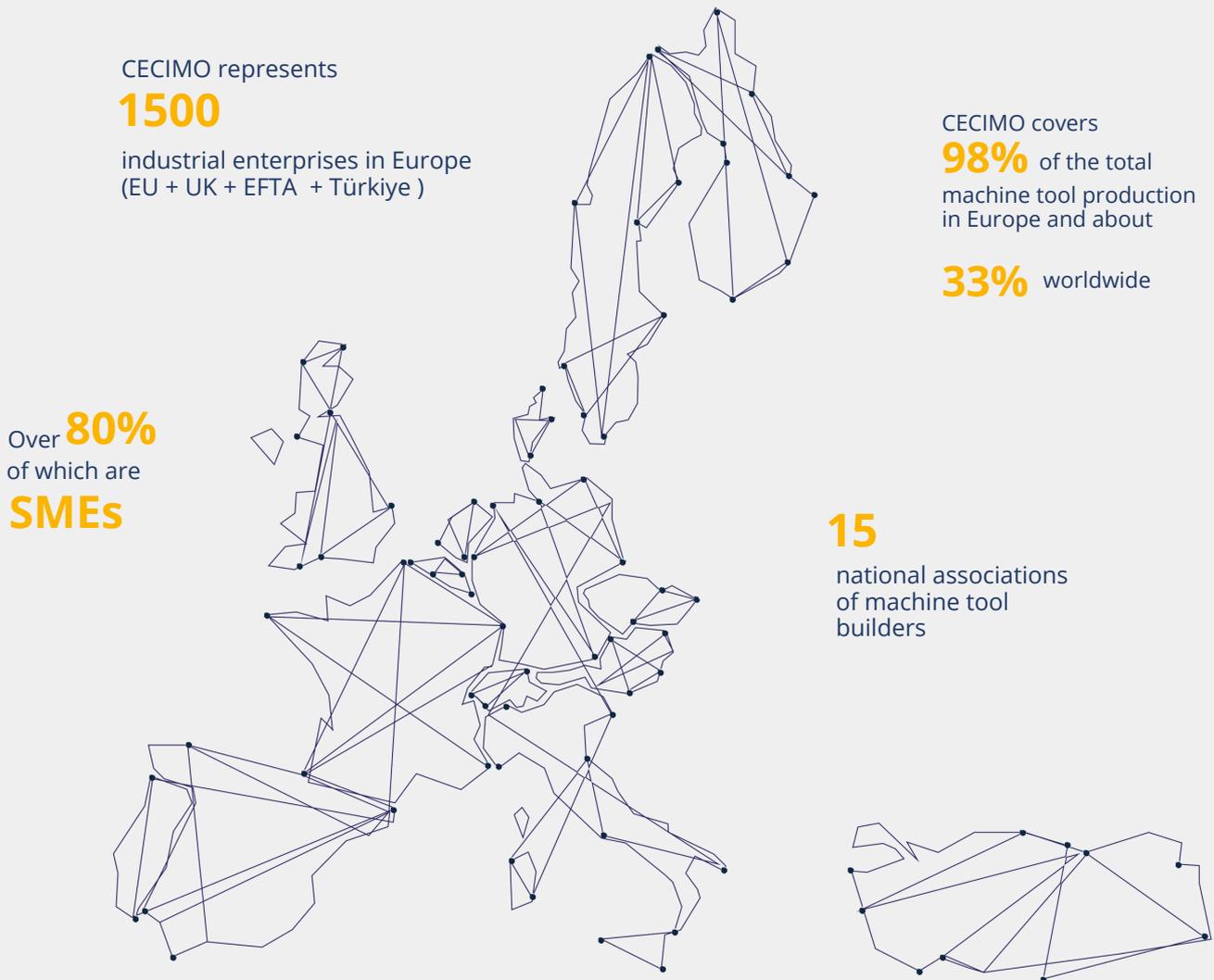
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