LCAMP

Learner Centric Advanced Manufacturing Platform

Analysis of the evolution of jobs in advanced manufacturing in the Basque Country

WP3 – Observatory

Learner centric Advanced Manufacturing Observatory

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GLOSSARY AND/OR ACRONYMS

ACBC Autonomous Community of the Basque Country

AFM Asociación de Fabricantes de Máquina Herramienta- Makina Erremintaren Fabrikatzaileen Elkartea- Machine Tool Manufacturers Association

AR - Augmented Reality

AGV Automated Guided Vehicles

CEX-FA Centros de excelencia en Fabricación automatizada - Spanish Network of Centres of VET Excellence on Automated Manufacturing

CNC Computer Numerical Control

CAM Computer-Aided Manufacturing

EICT Electronics, Information, and Communication Technologies

EQF European Qualification Framework

ERP - Enterprise Resource Planning

HMI Human Machine Interfaces

IVAF-EEI Instituto Vasco de Aprendizajes Futuros para la FP - Lanbide Heziketaren Etorkizuneko Ezagutzaren Institutua- Basque Institute of Future Learnings for VET

LCAMP Learner-Centric Advanced Manufacturing Platform

LLL Lifelong Learning

M2M Machine to Machine communications

MES Manufacturing Execution System

OECD Organisation for Economic Co-operation and Development - Organización para la Cooperación y el Desarrollo Económicos - Ekonomia Lankidetza eta Garapenerako Erakundea

OEE Overall Equipment Effectiveness

PLM Product Life Management

SME Small and Medium-sized Enterprises

TKNIKA Euskadiko Lanbide Heziketako Ikerketa Aplikatuko Zentroa - Centro de Investigación Aplicada de la Formación Profesional de País Vasco - Centre for Applied Research in Vocational Training in the Basque Country.

TAS-SAT-Technical Assistance Service - Laguntza Teknikoko Zerbitzua - Servicio Asistencia Técnica.

VET -LH-FP Vocational Education and Training - Lanbide Heziketa - Formación Profesional

VR Virtual Reality

CONTENT TABLE

EXECUTIVE SUMMARY 7
1. INTRODUCTION 8
2. METHODOLOGY 8
3. OVERVIEW OF THE IMPACT IN THE BASQUE COUNTRY 9
3.1. Advanced manufacturing in the Basque Country 9
3.2. Skills for advanced manufacturing (global) 10
3.3. Regional reports on skills and Jobs 12
3.3.1. Levers of change 12
3.3.2. Organizational Changes 13
3.3.3. Priority technologies 14
3.3.4. New profiles / new jobs 14
3.3.5. Recruitment 14
3.3.6. Competencies 15
4. INTERVIEWS WITH COMPANIES 16
4.1. List of jobs selected 16
4.2. Companies included in the analysis 17
4.3. Methodology for the interviews 19
5. JOB'S CHANGE ANALYSIS IN COMPANIES 20
5.1. Generic features for the digital and green transitions 20
5.1.1. Data acquisition systems are the basis for further innovations. 20
5.1.2. Monitoring of equipment and processes 21
5.1.3. Automation of processes 21
5.1.4. Companies with own product 21
5.1.5. Environmental sustainability 22
5.1.6. Artificial intelligence, virtual reality, robotics, digital twins, 3D printing 22
5.1.7. Organizational changes 22
5.1.8. Generic competencies and skills. 23
5.2. CNC operator 26
5.2.1. General description 26
5.2.2. Levers of change 26
5.2.3. Skills and competencies 27
5.2.1. Approaches for Upskilling and Reskilling 27
5.3. Maintenance Operator 28
5.3.1. General description 28
5.3.2. Levers of change 29
5.3.3. Skills and competencies 29
5.4. TAS operator 30
5.4.1. General description 30
5.4.2. Levers of change 30
5.4.3. Skills and competencies 31
5.5. Technical office assistant 31
5.5.1. General description 31
5.5.2. Levers of change 32
5.5.3. Skills and competencies 33
5.6. Automation technician 33
5.6.1. General description 33
5.6.2. Levers of change 34
5.6.3. Skills and competencies 34

5.7. Quality control assistant 35
5.7.1. General description 35
5.7.2. Levers of change 35
5.7.3. Skills and competencies 36
5.8. Assembly operator 36
5.8.1. General description 36
5.8.2. Levers of change 37
5.8.3. Skills and competencies 37
5.9. Industrial assembly supervisor - team leader 38
5.9.1. General description 38
5.9.2. Levers of change 38
5.9.3. Skills and competencies 38
5.10. Cold FORGING OPERATOR 39
5.10.1. General description 39
5.10.2. Levers of change 39
5.10.3. Skills and comptences 40
5.11. Others 40
5.11.1. Welder 40
5.11.2. Technical sales representative 41
5.11.3. Injection moulding machine operator 41
6. EXPERTS' VALIDATION 42
7. CONCLUSIONS 47
8. ACKNOWLEDGEMENTS 50
9. REFERENCES 50
10. INDEX OF IMAGES 52
11. INDEX OF TABLES 52

EXECUTIVE SUMMARY

This report presents an in-depth analysis of 12 advanced manufacturing jobs at the EQF level 5 of VET in the Basque Autonomous Community. Drawing from literature review and interviews conducted with companies in the field, several key findings have emerged..

- **Dynamic Job Landscape:** Jobs in advanced manufacturing are undergoing significant transformations due to the digital and green transitions within companies.
- **Influence of Industrial Context:** The evolution of jobs is intricately linked to various factors including company size, digital maturity, production types, business strategies, organizational culture, and regulations.
- **Variability in Job Evolution:** The evolution of specific jobs varies significantly depending on the individual company, highlighting the nuanced nature of workforce changes.
- **Digital Transformation Focus:** Digital transformation initiatives primarily aim at enhancing company performance, with less emphasis placed on individual well-being as the primary driver of change.
- **Limited Identification of New Jobs:** Few new job roles have been identified, with data analytics positions being predominantly mentioned, particularly in larger companies.
- **Changes in Specific Roles:** The typology of evolution identified points to changes in the traditional functions attributed to jobs, where extra functions derived from the digital and green transformations are added. Maintenance, Technical Assistance Services (TAS), and automation roles have undergone significant changes in certain cases.
- **Versatile Workforce Requirements:** Companies prioritize versatile workers with a flexible mindset towards change, a keen interest in learning, effective communication skills, and problem-solving abilities.
- **Specialized Profile Demands:** Companies seek highly specialized profiles tailored to their manufacturing processes. This specialization is often developed through in-house training and work experience, complementing foundational VET knowledge. Specialization is important but even more important is to understand that it should build upon strong foundational skills. Specialization without a strong base is impossible.
- **Call for Proficiency in Transversal Skills:** VET profiles are expected to possess a solid understanding of fundamentals, proficiency in computer/digital skills and languages, along with robust transversal skills to meet the demands of advanced manufacturing occupations.
- **Climate Emergency Measures:** Larger companies are more actively implementing climate emergency measures, such as automating carbon footprint calculations and enhancing energy efficiency. However, this process is still in its threshold.

In conclusion, the report underscores the dynamic nature of jobs in advanced manufacturing, driven by digitalization, greening, and industrial contexts. Companies are increasingly seeking versatile, specialized, and proficient individuals equipped with a blend of technical and transversal skills to thrive in this evolving landscape.

1. INTRODUCTION

In this report the Observatory of the Learner-Centric Advanced Manufacturing Platform for CoVEs (LCAMP analyses the impact of digital and green transitions on the competencies of the workforce in the advanced manufacturing industry, as well as the evolution of the main competencies related to a selection of jobs occupied mainly by people qualified by European Qualification Framework (EQF) levels 5-6 studies in companies located in the Autonomous Community of the Basque Country (ACBC).

The report aims to contribute to develop effective strategies for adapting Vocational Education and Training (VET) systems to the current needs of the society by analysing the evolution in skills requirement in jobs in the Basque manufacturing ecosystem. Jobs have been selected from among those affected by digital and green transition, within the industrial sector and taking into account those that make up a significant part of the current demand for VET graduates (EQF 5).

The contents of this report may be analytical material for some actors to develop activities in their respective fields, such as Tknika, VET Centres, IVAF, clusters and business associations, companies, etc. by providing them with basic information for the development of various activities like the integration of technology in VET centres, the revision of content (curriculum) and learning methodologies, the updating of continuous training, or the design of VET specialties among others.

The combination of desk (analysis of reports published on the subject in the last 5 years in the Basque Country) and field (direct analysis of the job positions selected, conducted through interviews with managers of 15 Basque companies) research activities followed in the elaboration of the report converges in the detailed description of the 12 selected jobs. The elements derived from the general analysis have been combined with elements conditioned by the context of companies, revealing specific results in relation to the 12 jobs.

2. METHODOLOGY

The research methodology combines: a) analysis of regional reports; b) selection of jobs for the analysis; c) interviews with companies.

Analysis of regional reports

The analysis of the four reports listed below gives a generic overview of the changes that the sector is facing in the ACBC. Insights of these reports are included in section 3.3.

- Report of the Spanish Network of Centres of VET Excellence on Automated Manufacturing, about the **identification of training needs for the preparation of job profiles in the automated manufacturing sector** (Homs, 2023)
- Report prepared by the Spanish cluster of machine tool manufacturers, about **the future of work in advanced manufacturing, new challenges, roles, and competencies** (AFM, 2022).
- Report drawn up by Innobasque, the Basque Innovation Agency, about the **technologies and professional skills 4.0 and the analysis of business demand** (Innobasque, 2019)

- Report prepared by Confebask about **the employment and qualification needs of Basque companies 2022** (Confebask, 2022)

Selection of jobs for the analysis

The selection of jobs is based on the data collected in job vacancies offer from Miguel Altuna LHII (2024) and JOIND platform. (2024). As a result, 12 jobs were selected for being considered relevant for VET graduates. The full process is described in section 4.1-4.2.

Interviews with companies

The report gathers information from 17 Basque companies. 15 teachers from 10 VET centres conducted face-to-face interviews under the coordination of Tknika. The full process is described in section 4.3.

Data processing, job change analysis.

The job change analysis based on interviews is carried out. The full process is described in section 5.

Findings and comparative analysis

A comparative analysis of the information gathered from direct interviews and the findings from reports. This information is available in section 6.

Periods of time covered by the report

The time frame of the research used in the interviews, is from five years up to the present, 2019-2024. Prospecting has also been carried out to identify the challenges facing companies in the short-term future.

3. OVERVIEW OF THE IMPACT IN THE BASQUE COUNTRY

3.1. ADVANCED MANUFACTURING IN THE BASQUE COUNTRY

Basque Companies are in a constant change to maintain national and international competitiveness and to survive. Important drivers of change are new technology adoption (WOF, 2023), sustainability and social wellbeing (Orkestra, 2024), digitalisation (Cecimo, 2023), increase the added value of their products by enhancing their competencies for design, prototyping, validation and advanced manufacturing (ACICAE, 2024).

Identifying the success of new technology adoption strategies in the region is difficult. The lack of common indicators and data available make it difficult to assess the extent to which the digital and green transitions are being deployed in different types of industrial companies. According to the data published by EUSTAT (Basque Institute of Statistics), the adoption of Industry 4.0 technologies is heterogeneous (see table below).

Table 1 Indicators of Industry 4.0 in the industrial establishments of the Basque Country according to employment stratum (% of establishments) 2022. Date July 12, 2023. Source: (EUSTAT, 2023)

Indicators for Industry 4.0	Establishments	
	Total (%)	10 or more employees (%)
Use of computer services "in the cloud"	26,6	50,2
Use of the internet of things (IoT)	13,6	25,6
Cybersecurity activities	20,8	47,7
Analysis of aggregate (Big Data)	12,2	25,9
Use of artificial intelligence systems	4,9	8,4
Use of 3D printers	2,6	8,7
Use of Robotics	2,3	12,9

3.2. SKILLS FOR ADVANCED MANUFACTURING (GLOBAL)

The analysis of the impact of the digital and green transition in specific jobs and workforce skills began with bibliographic research. Although sectorial reports and technology-specific analyses are available, there is nothing about changes in specific advanced manufacturing jobs. Within the available global reports about skills for industry 4.0, the data is not contextualized nor segregated by company sizes, sectors, production types or other variables not to mention by jobs or specific tasks. In any case, the most relevant findings are listed below.

Insights of the World Economic Forum (WOF, 2023, p. 7) considering the skills required for Industry 4.0 assures that:

- "Employers estimate that 44% of workers' skills will be disrupted in the next five years (until 2028)"
- "Six in 10 workers will require training before 2027, but only half of workers seem to have access to adequate training opportunities today".
- "The skills that companies report to be increasing in importance the fastest are not always reflected in corporate upskilling strategies".
- "Respondents express confidence in developing their existing workforce, however, they are less optimistic regarding the outlook for talent availability in the next five years".
- "Investing in learning and on-the-job training and automating processes are the most common workforce strategies which will be adopted to deliver their organizations' business goals".
- "Forty-five percent of businesses see funding for skills training as an effective intervention available to governments seeking to connect talent to employment".

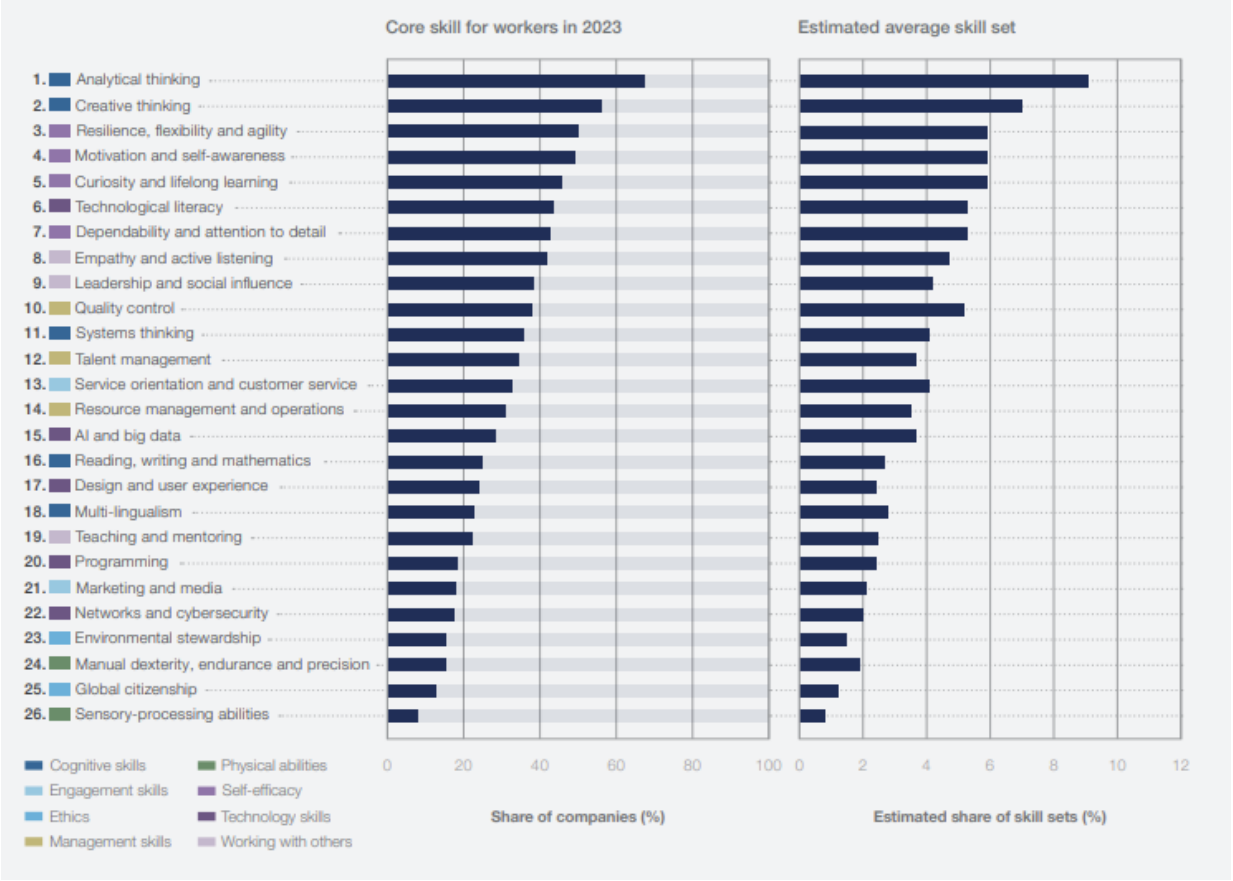

Figure 1 Share of organizations surveyed which consider skills to be core skills for their workforce Source World Economic Forum, Future of Jobs Survey 2023 (WOF, 2023, p. 38).

The OECD (2023), in " Skills for a Resilient Green and Digital Transition", offers generic information of skills evolution with special emphasis on Artificital Intelligence. There are not segregated details on skills for advanced manufacturing.

Cecimo (2024) in the report "From survey to strategy. Understanding Skills Trends in Advanced Manufacturing" gives an overview on the skill needs for machine tool industry.

The European Commission funds numerous initiatives of interest for the digital and green transition, like the following ones:

- The Digital skills and jobs platform (European Commission, n.d.) helps to enhance digital capacity-building.
- The "Skills for Industry" initiative adds to the efforts of EU countries and contributes to a shared long-term strategy on skills for industry in Europe. Selected publications include:
  - "Skills for smart industrial specialization and digital transformation" (Pedersen, Probst, Wenger, & Cracan, 2019)
  - "Skills for industry curriculum guidelines 4.0, Future-proof education and training for manufacturing in Europe 2019" (Dervojeda, 2019).
  - "Skills for SMEs, Cybersecurity, Internet of things and big data for small and medium-sized enterprises 2020" (Capgemini Invent; European Digital SME Alliance; Executive Agency for Small and Medium-sized Enterprises (European Commission), 2020).

Finally, in analysing the adoption of Industry 4.0 technologies in companies and their impact on jobs, it is essential to bear in mind that the incorporation of technological innovations depends heavily on the context and organizational aspects of the companies (Oeij., et al., 2023).

3.3. REGIONAL REPORTS ON SKILLS AND JOBS

At regional level, the analysis is focused on four reports about job profiles and skills for advanced manufacturing:

- Report of the Spanish Ministry of Education, Vocational Education and Training and Sport, coordinated by the Network of Centres of VET Excellence on Automated Manufacturing focus on the **identification of training needs for the preparation of job profiles in the automated manufacturing sector** (Homs, 2023)
  This report was produced among the 8 centres of the Network of VET Excellence centres of Automated Manufacturing in Spain. The aim was to identify the training needs of relevant job profiles in the automated manufacturing sector throughout Spain, including regional specificities. For the case of the Basque Autonomous Community, the study included interviews with 8 companies in the region.
- Report of the Spanish cluster of machine tool manufacturers (AFM) about **the future of work in advanced manufacturing. New challenges, roles, and competencies** (AFM 2022).
  AFM represents 90% of machine tool and advanced manufacturing technology companies in Spain. The report contains studies on the future of employment and future employment in the Advanced manufacturing field. The study was conducted among 19 companies from the Machine Tool Sector in 5 critical jobs, including Machining (EQF5), Industrial Maintenance (EQF5-6), SAT technician (EQF 5-6), Data Analyst (EQF 6) and IT experts (EQF 6). Technical or functional, social, methodological and personal competencies of these profiles were analysed (AFM, 2022).
- Report of the Basque Innovation Agency (Innobasque) about the **technologies and professional skills 4.0 Analysis of business demand** (Innobasque, 2019). Study carried out before the COVID pandemic including 19 companies from 5 sectors (Machine tool, Automotive, Energy, Aeronautic, EICT (Electronics, information, and communication technologies).
- Report of the Basque Employer Association (Confebask) about the **employment and qualification needs of Basque companies 2022** (Confebask, 2022). It gathers information from 600 companies on the types of profiles required, the qualification and training needs they demand and the difficulties they have in finding qualified workforce. The information in the Manufacturing, Construction and Services sectors.

Those reports give insights on the job profiles that the Basque industry is demanding, also a generic view on specific technical and more transversal skills related to occupations.

3.3.1.LEVERS OF CHANGE

Homs (2023) claims that “the speed of change in the current framework marks the transition towards the consolidation of new productive forms of networked companies, marked by the emergence of new technologies and a new type of worker adapted to the new times (…). This brings with it the insertion of changes in the organization of work, in processes and the inclusion

of innovative changes and improvements in products" . In the field of work and its relation to job profiles, the main **levers of change** are:

- The automation of production
- The digitisation of productive and social activity
- The fight to control the crisis and the climate emergency
- The ageing of the population
- The reorganization of geo-strategic balances on a global scale
- The reorganization of territorial criteria for the location of economic activity
- The fight against the gender gap in the labour and social spheres

According to AFM (2022) the levers of change for companies in the machine tool sector are, on the one hand, **productivity/efficiency improvement** and **process improvement** (figure 4).

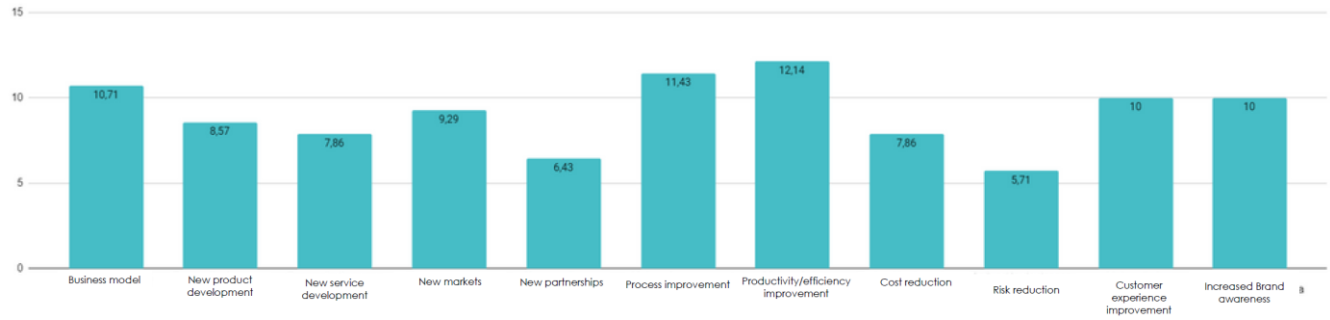

Figure 2 Transformation priorities/challenges in which companies are currently preoccupied with Source (AFM, 2022)

On the other hand, the main directions where companies from the sector are moving are a) **developing differentiated products and services** and b) **finding growth opportunities for existing products and services** (figure 5) (AFM, 2022).

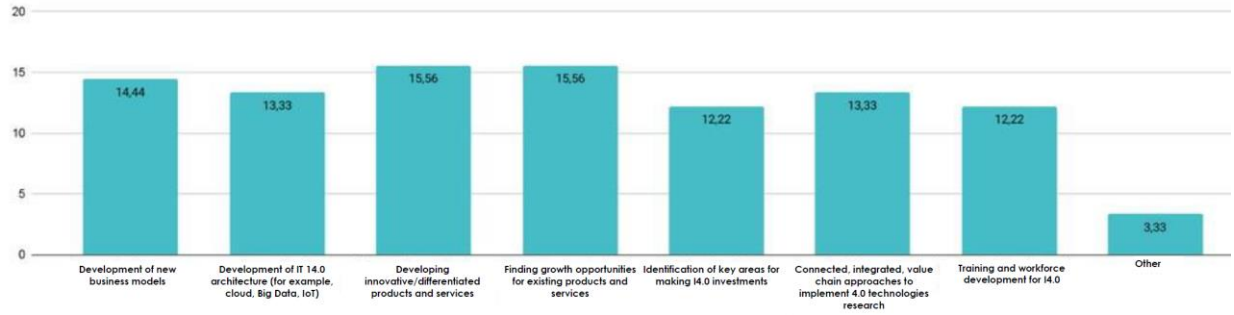

Figure 3 Digital transformation initiatives and priorities/challenges in which companies are moving towards Industry 4.0 (AFM, 2022)

3.3.2.ORGANIZATIONAL CHANGES

Digitalization and automation in the sector have reshaped work organization. **Organizational factors have the highest effect on skills development of the workforce** (Homs, 2023)**.** Roles have shifted from direct machine operation to team-based interaction, focusing on integrated production processes like programming and control. Each company adopts unique organizational models based on concrete production characteristics, resulting in varying task specialization and career paths for employees. This entails different qualification requirements for their staff, ranging from models with greater segmentation to others with greater versatility.

According to AFM, considering the future importance of **organizational aspects**, over 60% of the surveyed companies believe that the relationship between people management and Industry 4.0 are relevant, levers such as well-being, new work methods, compensation and benefits, or new models of organizational design. (AFM, 2022)

Aspects like sectors, size of the company, type of production, business strategies, organizational strategies, or regulations have a great influence in technology adoption and therefore on the skills demanded to the workforce. (Homs, 2023).

3.3.3.PRIORITY TECHNOLOGIES

The literature review shows a variety of ways to analyse the priority technologies that drive transformation in companies. While some reports present an exhaustive list of technologies (Innobasque, 2019) , others avoid explicit references (AFM, 2022), (Homs, 2023) (Confebask, 2022). Alongside artificial intelligence, the technologies identified as priorities by companies in the Basque Country according to Innobasque (2019)are mainly:

- Hybrid and/or multi-tasking machines/equipment
- Flexible, intelligent and connected production systems
- Agile human-machine interfaces
- Communication system between equipment of consecutive production processes
- Monitoring of equipment and processes and implementation in production processes
- Data collection, visualisation and management systems
- Intuitive and Multimodal Programming
- Virtual systems for simulation and control of plant processes
- Inspection and measurement systems integrated in the production process and connected online
- Monitoring systems during the entire life cycle
- Predictive maintenance systems and models for production systems
- Efficient manufacturing processes for advanced materials

3.3.4.NEW PROFILES / NEW JOBS

Concerning the creation of new jobs because of the digital and green transformations, the analysed reports refer more to show an evolution of jobs rather than the creation of jobs. That evolution is referred towards jobs based on workers' functions instead of jobs based on concrete tasks, mostly in SMEs (AFM, 2022) (Homs, 2023). Jobs tend to be modified rather than being destroyed or created.

In large companies there are a few new positions for data analytics or similar. The creation of departments or working groups to manage the digital transition is also mentioned for large companies. In SMEs, those functions are assigned to existing positions such maintenance staff, production managers or engineering departments. AFM (AFM, 2022) considers the Data Analyst profile new.

3.3.5.RECRUITMENT

Two out of the four reports give information about expected recruitment, (AFM, 2022) (Confebask, 2022). The former states that within the expected requirements for the next 5 years (until 2027) among the 19 companies surveyed, assembly technicians, mechanical engineers and automation technicians will likely be the most demanded. (AFM, 2022)

Table 2 Expected recruitment for the next 5 years among the 19 companies surveyed (AFM, 2022)

Jobs	% total requirements	Qualification level EQF5	Qualification level EQF6-7
Assembly technicians	27%	100%	0%
Mechanical engineers	18%	34%	66%
Automation technicians /electronics	17%	27%	73%
CNC Machining technician	13%	100%	0%
IT specialists	11%	0%	100%
TAS technicians	5%	27%	73%
Data analyst	2%	0%	100%
Maintenance	1%	100%	0%
Others	6%	36%	64%
TOTAL	100%	55%	45%

New recruitment is due to an increase in activity (57%), retirement (31%) and new activities (11.5%) (Confebask, 2022). By 2024 an increase of one point (58%), a decrease in the proportion of retirements (25%) and an increase in the number of new activities (17%) is expected (Confebask, 2024)

These recruitments are done through direct recruitment, via the Internet and, increasingly, through the job banks of educational centres. By departments, the most in demand are Production, Assembly and Maintenance (43%), Engineering and Quality Control (27%) and Marketing, Sales and Marketing (14.7%). Concerning new recruitment and focusing on the industrial sector, mechanical manufacturing (41.6%), electricity and electronics (18.1%), installation and maintenance (10.3%), chemistry (5.9%) and information technology (5.9%) are in first place, with a slight downward trend in mechanical manufacturing and installation and maintenance and an increase in chemistry, information technology and communications and transport and vehicle maintenance (Confebask, 2022).

3.3.6.COMPETENCIES

The 4 reports analyse different professional profiles, which makes any comparison difficult. In addition, a common taxonomy to describe skills and competencies linked to professional profiles or jobs, beyond the distinction between technical/transversal or hard/soft skill, is non-existent.

AFM (2022) provides the necessary competencies clustered by technical, methodological, personal and social for 5 profiles (CNC machining technicians, Maintenace technicians, TAS technicians, Data analysts, IT specialists), together with the qualifications required for these jobs. Innobasque (2019). clusters competencies by strategic, structural, activity related and transversal. The table below summarizes four recurrent aspects:

- The organizational dependencies of the functions linked to the jobs, as underlined in section 3.3.2, influence in the set of skills required for occupations.
- Technical professional competencies form the core of the occupations: the trend is towards higher demands on professional skills (Homs, 2023). Companies expect a strong technical base from VET graduates that will further specialize either in the job training or by LLL courses or both. For the purely technical competencies, due to the changes towards more function-based jobs, IT skills and analytical skills are aggregated to almost all job categories.

- Transversal competencies are highly valued. It is remarkable that the three out of four reports mention similar transversal skills: problem solving, communication, collaborative work, creativity and innovation, data analysis and interpretation, attitude for learning and languages (AFM, 2022) (Innobasque, 2019) (Homs, 2023).
- Systemic strategies for talent management are proposed (AFM, 2022).

4. INTERVIEWS WITH COMPANIES

4.1. LIST OF JOBS SELECTED

12 jobs were selected based on the data collected in job vacancies offer from Miguel Altuna LHII (2024) and JOIND platform (2024) for being considered relevant for VET graduates in the field of Advanced manufacturing in the Basque Country. The employment exchange service from Miguel Altuna LHII covers information about job vacancies for VET graduates for the period 2017-2021. Information based on DUAL training from Miguel Altuna is also considered for the selection. The JOIND platform, on the other hand, is the employment exchange service from AFM. The data gathered in that platform covers the period June 1st, 2022, to December 31st, 2023.

The criteria to select the jobs is established by the LCAMP observatory:

- Jobs where advanced manufacturing technologies are used
- Jobs that are changing due to twin transition
- Jobs with high rates of employability in the region
- Jobs from sectors considered strategic in the region
- Jobs with EQF5 requirements

Table 3 List of jobs analysed in the report

Nº	Selected jobs	VET Level
1	CNC technician (Operator + programmer)	EQF5
2	Maintenance Operator (electrical, mechanical and others)	EQF5
3	After Sales Service technician-TAS operator (electrical, mechanical and other)	EQF5
4	Technical Office assistant (mechanical, electrical, product development and other)	EQF5
5	Automation technician & Robotics	EQF5
6	Quality Control assistant	EQF5
7	Assembly operator	EQF5
8	Industrial Assembly Supervisor	EQF5
9	Cold forging operator	EQF5
10	Welder	EQF5
11	Technical Sales representative	EQF5
12	Moulding machine technician	EQF5

4.2. COMPANIES INCLUDED IN THE ANALYSIS

Jobs are heterogeneous across companies, the tasks to be performed by the workers and the necessary skills will not always be the same. To understand the impact of the context on jobs, the analysis has been carried out considering three main variables:

- **Size:** big companies (more than 250 employees), medium (between 50-250 employees) small (less than 50 employees)
- **Type of production**: customized short production batches, serial production, automatized production. As companies with *own product* have shown singular characteristics, it is considered as a variable.
- **Sectors**: automotive, machine tool manufacturers, components manufacturers, equipment manufacturing, electric, biotechnologies, multisector.

The **relevance of the analysed jobs within the value chain** in the companies has also been considered. Not all jobs have the same weight in the value chain, therefore the priorities for their digitalization may vary.

Digital maturity. There are differences in the digitalization levels of companies. The variable that best differentiates the level of digitalization is the size of the companies, ahead of the type of sector or type of production. The level of digitalization and consequently the level of integration of I4.0 enabling technologies is lower in small companies. However, it is noteworthy that the small companies interviewed are ready to give great technological leaps if one looks at their own machines, short term investment and strategies.

In the table below, information about the companies is given.

Table 4 List of companies participating in the study

Company	Nº of employees	Activity	Sector
BIDEGAIN	47	Valves manufacturing	Multisector (wood, metal, building automotive r
BIELE GROUP	250	Turnkey solutions for production plants	Multisector
DOMOTEK	10	Manufacturing machinery for 3D bio printing	Additive Manufacturing
DS AUTOMATION	22	Maintenance and Industrial Automation Solutions.	Automation
ECENARRO	71	Manufacture of fasteners and special parts by cold forging	Automotive
GAMESA GEARBOX	55	Design, manufacture and supply of wind power transmissions	Energy
GH CRANES&COMPONENTS	240	Manufacture and design of cranes, and other lifting equipment.	Multisector
GOIMEK	85	Precision machining	Machine tool
HAIZELUR	33	Precision machining	Multisector
KENDU	28	Manufacturing of tools	Machine tool
KSB	200	Design and manufacture of pumps, valves and services for fluid transfer applications	Multisector
LEMU-Ibarra	123	Manufacture of paper converting solutions	Multisector

MAIER	902	Manufacture of plastic parts and technical subassemblies for industry	Automotive
ORMAZABAL	583	Manufacture of equipment for electrical distribution and control	Electric
P4Q ELECTRONICS	232	Manufacture of electronic equipment	Multisector
TECUNI	288	Electrical works and maintenance and electrical infrastructure	Electric
URUMEA MEKANIZATUAK	27	Machining	Multisector

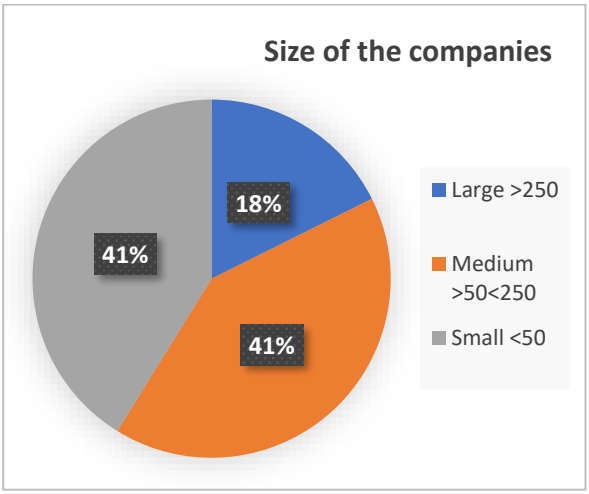

Figure 4 Size of the companies.

4.3. METHODOLOGY FOR THE INTERVIEWS

15 teachers from 10 Basque VET centres interviewed representatives of 17 companies. In most of the cases, the interviews have been carried out face-to-face with 2 representatives of the company, preferably a human resources manager and a production manager. Each interview took between 1,5 and 2 hours.

Table 5 List of VET centres involved in the study

VET Cetre	Location
CIFP Armeria Eskola LHII	Eibar
Goierri Eskola	Ordizia
CIFP IMH LHII	Elgoibar
CIFP Miguel Altuna LHII	Bergara
CIFP Tartanga LHII	Erandio
CIFP Tolosaldea LHII	Tolosa
Politeknika Txorierri	Derio
CIFP Zornotza LHII	Zornotza
CPIFP Egibide LHIPI	Vitoria-Gasteiz
CIFP Usurbil LHII	Usurbil

Figure 5 VET centres involved in the analysis.

The interviews covered three main aspects as shown in figure 6.

- Analysis of changes the company is going through and their impact in tasks and jobs.
- The identification of competencies arising from the changes for those jobs.
- The identification of the needs of the target workforce.

Figure 6 Interview's process.

5. JOB'S CHANGE ANALYSIS IN COMPANIES

This section describes how the 12 jobs selected are changing among the interviewed companies and its impact on the workforce. As seen in previous sections, the context of the jobs, company size, sector, and type of production, makes a difference to understand and measure the magnitude of the impacts. It is also true that, analysing the levers of the changes there are some common features that appear in most of the companies. Therefore, before describing each of the jobs, the general features are described hereafter:

Context

The analysis takes a sample of 17 companies from different sectors with diverse industrial activities (see **¡Error! No se encuentra el origen de la referencia.**). 41% are small sized companies, 41% medium and 18% large.

The **size of the company** is one of the variables that makes a difference in the rhythm and level of digitalization. The automatization and digitalization levels are higher in large companies. Small companies are still in an early digitalization stage. Another substantial difference is given by the companies with own product, where the customization of products and services is leading to significant changes. The main **lever of change** that affects multiple jobs is to improve production efficiency. Other factors mentioned are environmental aspects, market driven factors such digitalization of entire value chains or added values services.

5.1. GENERIC FEATURES FOR THE DIGITAL AND GREEN TRANSITIONS

5.1.1. DATA ACQUISITION SYSTEMS ARE THE BASIS FOR FURTHER INNOVATIONS.

The modernisation of ERP systems connected with data acquisition systems are impacting in most of the jobs of those companies. Workers interact with Manufacturing Execution Systems (MES) and Human Machine Interfaces (HMI) in many analysed jobs. Similarly, data management and document management systems for (process) documents i.e. plan and control sheets, create a relevant impact in many jobs.

The process is progressive, some companies that are in the early stage of change (around 18%) start with machine retrofitting and data acquisition systems to move towards paperless production processes where still the interaction of the workers with the systems is very present, whereas others (53%), normally large companies, show more sophisticated data collection systems, introduction of IoT infrastructures and the use of Big Data for well defined purposes (improvement of preventive maintenance, analysis of set-up times of machining machines, improvement of performance in the manufacture of milling tools).

In any case. it is seen that, as digitisation progresses, companies are integrating the collected data within other digital system in the company for its subsequent analysis for the implementation of improvements.

5.1.2.MONITORING OF EQUIPMENT AND PROCESSES

In companies where machining is a relevant activity (precision machining, tools and dies manufacturing) data is collected directly from the machines. Manufacturing Intelligence systems are used to calculate OEE (Overall Equipment Effectiveness), manufacturing incidences and other relevant data. The direct acquisition of data from the machines is seen also in other activities besides the machining such as cold forging, injections and others. In some companies, data is also collected in assembly lines with relatively digitalized, workplaces although there are still a lot of manual operations carried out by workers.

The monitoring of data also facilitates the traceability of goods, components to understand the main process variables and their effects on products. For instance in the **automotive sector** OEMs (Original Equipment Manufacturer) are requesting to the suppliers the availability of data related to their products in open and collaborative data space (Catena-X Automotive Network e.V., n.d.). Similar request are observed also in other sectors. This requirement is forcing companies to speed up the establishment of data acquisition systems.

In all these **cases there is a clear change of the workers role**. Workers, in addition to producing products, often become responsible for the data associated with these products. Promoting data culture is becoming a necessity in the automotive industry. The data collection requirements encompass the traceability of the full value chain, from raw materials to shipping, where multiple production and control parameters are requested.

5.1.3.AUTOMATION OF PROCESSES

Large companies show a clear trend towards automation. In medium and small companies even if the tendency is palpable, automatization is still not so perceptible, it is limited to more specific operations such as the inclusion of a welding robot or one or more assembly operations.

More specifically for those companies with machining activities, (71%) there is a generalized trend to invest in state-of-the-art machines, flexible, hybrid or multi-task machines equipped with HMIs and data acquisition systems and with high degree of automation. Palettized feeding systems that allows 24x7 productions are on the agendas of almost all.

Concerning the intra logistics, warehouses and supply of materials, some companies, (12%) have already digitised the warehouse control and some (6%) have already digitised the supply to the production lines, and plan to increase the area of digitisation, while others are planning to do so in the near future. Automated warehouses for products and tools are commonly used. 3 companies showed their plans to digitise the control of spare parts and machining tools in a near future.

Among other technologies mentioned in the interviews, already operative in same cases and foreseen in a short future, there are findings of automatized measurement, control systems by artificial vision, quality control integrated in processes and Automated guided Vehicles (AVG).

5.1.4.COMPANIES WITH OWN PRODUCT

The companies with own product (29%) show a clear driver of change in the introduction of technology in their products. Those innovations make the products evolve and, therefore, a new range of technologies and knowledge is demanded. The development of digital/online services for customers related to advanced predictive maintenance, product configurations, online monitoring the state of manufacturing orders and similar online services are seen in some companies. Ultimately, the front runners talk about new innovations such AI applied to products,

own embedded IoT system and big data to motorize and control the products aiming to optimize the operations of the final product.

Companies with their own product mark these milestones as being of paramount importance. It leads to the need for organizational changes that respond to production in discontinuous cycles on the one hand and to an increase in product customization on the other. In addition to organizational changes, these trends are leading to more specialized professional profiles with greater technical knowledge of the product, processes and capital goods. In turn, there is a need for greater versatility between jobs within the same production section and even between different ones. It is worth mentioning that versatility is a general comment, not only by the companies with own product.

5.1.5.ENVIRONMENTAL SUSTAINABILITY

Changes in regulations and an increase in the environmental awareness among companies is leading to adopt changes related to environmental aspects within the companies. Once again, the rhythms for adoption of environmental measures vary from company to company, being the large companies the leading ones. Companies with own product are adopting environmental measures for their products such as the elimination of certain greenhouse gases, modification of their products designs, generation of new products and new manufacturing lines. Companies have also shown awareness for sustainability due to regulations in their supply chains.

The calculation of carbon footprint and greenhouse gas emission reduction commitments are present in the interviewed companies (around 35%). Actions such as calculation of the carbon footprint, waste treatment, energy efficiency in equipment, lines and buildings, installation of solar panels are observed.

There is a cultural change towards sustainability issues.

5.1.6.ARTIFICIAL INTELLIGENCE, VIRTUAL REALITY, ROBOTICS, DIGITAL TWINS, 3D PRINTING

Among the interviewed companies, those at the forefront of digitalization consider AI as the natural progression for data analysis. Despite widespread recognition of AI's potential, the majority of interviewed companies are not actively pursuing AI projects. However, three companies have included AI in their short-term agendas.

In terms of AR and VR initiatives, three companies, one medium-sized and two large, have expressed intentions to integrate these technologies in the near future.

Regarding robotics, the companies surveyed generally have limited utilization due to their specific production requirements. Two companies employ robotic cells for automated welding, while one medium-sized company has successfully implemented AGVs. Although the current use of cobots is limited, there are plans to incorporate them soon.

One notable mention in the realm of 3D printing is a company specializing in manufacturing 3D printing machines for biotechnology. However, large-scale 3D printing component manufacturing is not prevalent among the studied companies.

The adoption of Digital Twins as a short-term strategy is mentioned by only one company.

5.1.7.ORGANIZATIONAL CHANGES

There is a generalized opinion that the job profiles are evolving, i.e. changing from blue collar workers to management. A transition towards a wider definition of tasks and jobs is

appreciable, confirming what is mentioned in (Homs 2023) and (AFM 2022): companies refer to “workers’ functions” more than “workers’ task”, people are not linked only to specific machines but to functions to be carried out.

The companies claim the necessity for **adaptability to markets/customers** changing specification. They stress not only the need for flexible production that adapts products to customer requirements, but also the right adaptability skills of workers in order to make these adaptations happen.

Organizational changes as a consequence of the digitalization are envisaged, as to provide more autonomy to all the levels of the company. Data-driven management is being strongly promoted. New working methods and organizational models are taking place.

More and more, a systemic view of all the company and the cross relation among jobs is highly appreciated. Versatility, understood as the capability of individuals to perform multiple roles or tasks within the production line or process, is recognised as a very relevant characteristic for workers. As a result, workers have the flexibility and skills to handle different responsibilities or positions as needed, contributing to increased efficiency, adaptability, and productivity within the manufacturing environment.

5.1.8.GENERIC COMPETENCIES AND SKILLS.

Concerning the changes in competencies brought by the digital and green transitions, companies often cite technical skills enhancement focused on deeper knowledge of the technologies utilized in their specific work environment.

Essential technical skills that they aim to improve include **data management, digital literacy, familiarity with internal procedures, and proficiency in management tools**.

Companies emphasize the vital role of **basic technical knowledge** acquired in VET centers, viewing it as a robust foundation for specific technology expertise.

Interdisciplinary skills are increasingly valued, with roles traditionally focused on mechanical expertise now incorporating electronics or IT skills, especially in maintenance positions. Transversal (soft) skills such as problem-solving, decision-making, in collaboration, leadership and effective communication are consistently highlighted.

Proficiency in foreign languages, particularly English, is crucial due to the rising need for interaction with international stakeholders.

Upskilling-reskilling processes

Companies often set up in-house trainings related to the functioning and program of existing and forthcoming new machines. Training of workers in external courses (lifelong learning) are also widely used, being VET centres the principal providers of such trainings. Technology providers (machine, equipment, engineering solutions or software vendors) are also recurrent training providers.

The interviewed companies have well-established **onboarding systems**, typically involving a learning period before employees become autonomous, especially with complex machinery. Internal training programs play a crucial role due to this. Those programs would need to be updated according to the evolution of workers competencies.

Defined **career paths** to reach certain positions are common, offering progression to positions of greater complexity or responsibility. Many intermediate managerial roles, such as line managers and quality control technicians, are filled by VET graduates with extensive experience and comprehensive knowledge of products, processes, and machines. For instance, in a company producing its own products, progression may involve starting as a machine operator,

advancing to CNC machine programming, then to roles like production manager or even area manager overseeing work teams and continuous improvement. These pathways are long-term and can take several years to complete. Personalized learning programs for workers are established in a few companies although is not the most common strategy.

DUAL training systems and internships are frequently utilized to develop candidates' technical competencies specific to the company.

Table 6 Jobs analysed in companies

Company	**#01**	**#02**	**#03**	**#04**	**#05**	**#06**	**#07**	**#08**	**#09**	**#10**	**#11**	**#12**	**#13**	**#14**	**#15**	**#16**	**#17**	
Vet centre interviewing	Goierri Eskola	Goierri Eskola	Miguel Altuna	Miguel Altuna	Miguel Altuna	P. Txorierri	Tolosaldea	Tolosaldea	Zornotza	Zornotza	IMH	Tartanga	Tartanga	Egibide	Armeria	Usurbil	Usurbil	% present
Size (Small, Medium, Large)	S	M	M	S	M	S	M	L	L	L	M	L	M	S	M	S	S	
Jobs																		
CNC operator	●	●	●	●	●	●	●	●	●		●					●	●	71%
Maintenance Operator	●		●	●	●			●	●		●	●	●			●	●	82%
TAS operator		●			●	●	●	●	●				●			●		53%
Technical office assistant	●	●		●	●	●	●	●	●		●					●		65%
Automation technician		●				●			●				●	●				35%
Quality control assistant	●	●	●	●	●	●			●		●		●			●	●	65%
Assembly operator		●	●	●	●	●	●	●	●	●					●	●		65%
Industrial assembly supervisor/ team leader	●				●		●		●	●	●					●	●	65%
Cold forging operator			●															6%
Welder		●			●	●			●							●	●	35%
Injection moulding machine operators									●									6%

5.2. CNC OPERATOR

5.2.1.GENERAL DESCRIPTION

CNC operator (ESCO 7223.4): "*Computer numerical control machine operators set-up, maintain and control a computer numerical control machine in order to execute the product orders. They are responsible for programming the machines, ensuring the required parameters and measurements are met while maintaining the quality and safety standards"* (ESCO, n.d.) .

Although the job is identically named in all the selected companies, the related job competencies can vary depending on the company context. The definition give by ESCO is well accepted, the general function of the operator includes also tasks related to quality control and maintenance of CNC machines.

On the other hand, to maximize productivity rates, CNC programming are made outside the actual production machines, normally carried out by specialized workers in technical offices with knowledge of CAM. Operator in machine made the adjustments of the programs or set up of certain parameters. The subcontract of the programming of complex machining processes have been observed in one company where machining is not their main activity.

Also, tasks based on data analysis and problems solving are derived to operators.

Presence in sectors

71% of the companies interviewed include CNC operator in the study. 67% of those consider the machining activity as relevant activity for their companies. Furthermore, those jobs are occupied by VET graduates. All the sectors represented in the study include CNC operators jobs.

5.2.2.LEVERS OF CHANGE

CNC operator is valued as a changing job by most of the companies (60%).

The most recurring levers of change identified for are the following:

- Investment in state-of-the-art machinery: flexible, hybrid or multi-task machines equipped with HMIs and data acquisitions systems.
- There is a generalized trend to monitoring the data coming from CNC machines. It goes from the implementation of Management Intelligence systems to exploit data from CNC machines to IoT and Big data technologies. Usually, the aim is the improvement of OEE (Overall Equipment Effectiveness).
- The workplace is connected to MES and ERP systems.
- 24x7 running machines with palletising systems or automatized feeding systems.
- Tailored production. Small production batches.

Looking for a short-term trends, the present levers will remain

- More automation of CNC machines (palletization eta and inclusion of sensors to improve safety functions, automatized measurement)
- BigData and AI applied to the predictive maintenance of CNC machine
- Product customization
- Inclusion of sensors to improve the control of spare parts
- Traceability of tools, automatized warehouses for tooling
- Automatized inspections and/or measurement systems in the workplace

- Machine Learning to improve efficiency and quality

5.2.3.SKILLS AND COMPETENCIES

Changes in technologies entail the evolution of both technical and transversal competencies. A generalized comment for CNC operators is that the organization of the job is changing with a development of workers' autonomy in the workplace, greater involvement in the production processes and higher interaction for the systems.

Concerning the **technical skills** the increase of complexity of products, increasing demands for precision and quality, the complexity of the machines request to higher knowledge in CAM processes, digital skills, data analytics and languages, specially English.

More concrete requirements mentioned for CNC operators in some companies (60%):

- Interactions with MES and ERP systems
- CAD/CAM programming skills
- Predictive maintenance
- Complex drawing's interpretation and spatial vision
- 5S, lean manufacturing
- Cybersecurity in OT systems

Regarding the transversal competencies the companies agree on the need of the aforementioned soft skills related to CNC operators i.e. involvement, problem solving, decision making, interdisciplinarity, interest in learning, communication.

Other characteristics observed for this job are **adaptability to production needs, versatility, mindset for data culture**. High **knowledge on the product's functionalities** is also highly valued for CNC operators.

Qualification requested for this job:

- Production Scheduling in Mechanical Manufacturing EQF5
- Machining technician EQF 4
- Specialization program on precision machining EQF 5

5.2.1. APPROACHES FOR UPSKILLING AND RESKILLING

100% of the interviewed companies have training processes for CNC operators in place. From onboarding trainings to very specific high-tech trainings. Internal trainings and on the job trainings are the main training methods used. VET centres are important training providers for CNC operators in Lifelong Learning (LLL) programs related to CNC. Also, technology provider companies.

As has happened over the years, CNC workers have moved to more complex positions as they have gained experience, always reinforcing their knowledge with external training actions. Typical pathway would be operators start working on simpler two-axis or cylindrical machines and over time move to 5 and 6-axis machining machines. In many companies the professional progression leads to positions such as Tooling Design Technician, CAD CAM process technician, Quality, warehouse supervision and purchasing and so on.

It is observable the relevance of LLL programs and external training providers to assists those paths.

For CNC, operator **versatility** is more and more requested, at least among machines with similar characteristics. The requires adapting to changes, and attitudes toward LLL.

5.3. MAINTENANCE OPERATOR

5.3.1.GENERAL DESCRIPTION

In the interviews with companies the *maintenance operator* job's definition varies, depending on the type of company. The definitions found corresponds to the following:

Industrial maintenance supervisor ESCO 3515.1.6: "*Industrial maintenance supervisors organise and supervise the activities and maintenance operations of machines, systems and equipment. They ensure inspections are done according to health, safety and environmental standards, and productivity and quality requirements"* (ESCO, n.d.).

Electrical maintenance operator ESCO 7411.1: "*Electricians fit and repair electrical circuits and wiring systems. They also install and maintain electrical equipment and machinery. This work can be performed indoors as well as outdoors, in nearly every type of facility"* (ESCO, n.d.).

Industrial machinery mechanic ESCO7233.7: "*Industrial machinery mechanics work on new machinery and equipment in operation. They set up for the specific application and build accessories if necessary, perform maintenance and repair, and run diagnostics to find faults in systems or parts that need replacing"* (ESCO, n.d.).

According to interviewed companies the *maintenance operator* job is changing substantially. Depending on the sector, size and type of product, the **functions for maintenance operators** are specified in different ways.

There are companies where the maintenance operators not only are responsible for preventive and corrective maintenance of equipment but also for the automations and improvements in production lines. Due to automation and digitalization, job profiles that used to involve purely mechanical and/or purely electrical maintenance tasks, nowadays are complemented with mechatronics and IT related tasks. New functions such as PLC programming, maintenance of data acquisition systems, communications between machines and systems and security regulations are more and more affecting this job.

There are different strategies for carrying out maintenance tasks. It is often the operators themselves who carry out preventive maintenance tasks at their workstations, and in some cases even simple corrective maintenance tasks (67%).

Given the increasing complexity of machines, equipment and manufacturing lines, and also due to the lack of personnel with sufficient knowledge, different options are observed among the companies interviewed. Some opt to subcontract part of the maintenance to the technical services of the machine brands and outsource repairs and periodic repairs. In other cases, given the complexity of the tasks, the entire maintenance service is outsourced to specialists in advanced technologies, while the management tasks remain with the parent company.

Presence in sectors

This job is present in all the sectors and manufacturing plants considered in this study with the exception of one small company. 82% of the interviewed companies included this job in the analysis. In some cases (53%), due to the inclusion of complex machines, such as 5-axis CNC machine, or the inclusion of AGVs, the maintenance of these specific elements becomes an external process, i.e. an outsourced service.

5.3.2.LEVERS OF CHANGE

Medium and large size companies consider maintenance operator position as a changing job. Due to the twin transitions the complexity of the technologies implemented in production lines have brough a change in the functions of maintenance operators. It is common that maintenance operators are in charge of implementing and maintaining the automation in productions lines.

The most recurring levers of change identified for maintenance operators are the following:

- Automation of production lines or integration of complex machinery, including retrofitting of existing machinery.
- Development of advanced predictive maintenance based on data collection.
- Organizational changes that integrate the simple maintenance operations to production under the supervision of the machinery operators.
- Evolution in the maintenance monitoring system due to the outsourcing of periodic and corrective maintenance of equipment in case of complex machines. This evolution is driven by the need to meet control requirements mandated by tool and equipment manufacturers for certification and legal compliance.
- Participation in interdisciplinary teams to implement improvements in the manufacturing processes. The improvements can have different origins, can be proposed by both engineering and machine staff.
- Higher collaboration with technical departments.

Some companies mention a trend toward the use of AI for predictive maintenance in a short future, which will obviously have an impact on the skill needs for maintenance operators.

5.3.3.SKILLS AND COMPETENCIES

Technical skills identified as new in the interviews are listed below. Note that the term “new” could be subjective, what is new for some companies can be mature in other.

- Implementation and maintenance of machine-to-machine communications systems
- Data capture from manufacturing equipment
- Industrial communications
- For those companies with a more advanced level in machine-to-machine communications, there is an evolution of the competencies towards industrial IT maintenance profiles
- Multi-brand robot programming (the mention was made for welding robots)
- Multi-brand PLC programming
- Artificial vision systems
- Alignment of tools by laser
- Alignment of tools by laser
- Big data and IA skills are mentioned in the most digitalized companies, still a minority
- Cybersecurity

Concerning **transversal competencies,** confirming what it was stated at the beginning of this section, companies focus on the development of analytical skills and increased organizational, planning and management skills.

Qualification requested for this job:

- Industrial Mechatronics EQF 5
- Automation & Industrial Robotics EQF 5
- Double qualifications or Qualification + specialization courses are very much valued i.e.

    - Production Scheduling in Mechanical Manufacturing EQF5 + Automation & Industrial Robotics EQF 5
    - Industrial Mechatronics EQF 5 + Specialization Course in Digitalisation of Industrial Maintenance
    - Industrial Mechatronics EQF 5 + Specialization Course in Smart Manufacturing
- Mechanical Engineering EQF 6
- Electronic engineering EQF 6

5.4. TAS OPERATOR

5.4.1.GENERAL DESCRIPTION

Electrical eta mechanical TAS operator-After-sales service technician (ESCO 2433.1): **"***After-sales service technicians provide after-sales service support to customers, such as the installation, maintenance and repair of the sold products. They take corrective actions to ensure customers' satisfaction"* (ESCO, n.d.).

Depending on the company, a distinction may be made between commissioning after-sales service and technical support.

TAS operators require in-depth knowledge of the operation of the products as well as its components for both commissioning of products and diagnosing and resolving problems at the customer's premises. Furthermore, for technical services in addition to corrective maintenance, their functions may also include remote predictive maintenance with the monitoring of installed equipment.

Presence in sectors

Among the interviewed companies 53% have TAS services. Usually, the TAS operator job appears on those companies with own product (57%). It also appears when the main activity of the company is the automation of third-party production lines or machines (43%).

This job requires, - besides advanced technical competencies - languages proficiency and availability for travel and/or flexibles working timetables.

5.4.2. LEVERS OF CHANGE

The companies rated the change level for TAS operators as the highest among the jobs included in this study.

Among the reasons for the transformation of the tasks of this job the following are found:

- Integration of digital elements into the operation of the product that provide new safety functions, operation monitoring capabilities and extended operating functions in critical environments.
- Installation or export of automated processes, integrating HMIs, IoT systems or robots to other plants.
- The transformation of products following environmental legislations, requires the electrification of those to remove fossil fuel-based technologies.
- Increased security requirements lead to non-outsourcing of installation services becoming functions for TAS operators.
- Remote support services to solve customers' problems without the displacement of the technicians.

- Increased environmental legal requirements such as handling certain gases or hazardous materials.

According to one company an important lever of change in the near future will be the integration of AI for monitoring and preventive maintenance of products installed in customer's facilities.

5.4.3. SKILLS AND COMPETENCIES

Regarding new skills requirements for TAS operators, needs on specific technical skills are identified.

- Development of sensorics knowledge
- Remote maintenance systems
- Data analysis
- Big data and AI
- Cybersecurity
- Identification of emerging technologies

With regard to the transversal skills, the companies that have analysed this job emphasise communication, networking, analytical thinking and problem-solving skills.

Qualification requested for this job:

Usually to promote to this job the work experience is compulsory. The background could be diverse:

- Production Scheduling in Mechanical Manufacturing EQF5
- Industrial Mechatronics EQF 5
- Automation & Industrial Robotics EQF 5
- Double qualifications are very much valued
    - Production Scheduling in Mechanical Manufacturing EQF5 + Automation & Industrial Robotics EQF 5
    - Industrial Mechatronics EQF 5 + Specialization Course in Digitalisation of Industrial Maintenance

5.5. TECHNICAL OFFICE ASSISTANT

5.5.1. GENERAL DESCRIPTION

The job covered in this section is Technical Office Assistant (mechanical, electrical, product development and other). Depending on the type of organizational structure of the company, this job therefore corresponds to various definitions:

Mechanical engineering drafter (ESCO 118.3.11): "*Mechanical engineering drafters convert mechanical engineers' designs and sketches into technical drawings detailing dimensions, fastening and assembling methods and other specifications used for example in manufacturing processes"* (ESCO, n.d.).

Electrical drafter (ESCO 3118.3.6): "*Electrical drafters support engineers in the design and conceptualisation of electrical equipment. They draft, with the support of specialised software, the specifications of a varied number of electrical systems such as voltage transformers, power plants, or energy supply in buildings"* (ESCO, n.d.).

Product development engineering drafter (ESCO 3118.3.12): "*Product development engineering drafters design and draw blueprints to bring new concepts and products to life. They draft and draw detailed plans on how to manufacture a produc"t* (ESCO, n.d.).

Other functions not included in ESCO definitions are observed in the interviewed companies. Functions such as support in the selection of materials and components, project monitoring and assistance to preparation of budgets.

In some companies, in addition to preparing drawings for production, functions such production programming and numerical control programming are carried out by Technical Offices.

Therefore, although the job position Technical Office Assistant is regarded commonly for all the interviewed companies, its functions vary from firm to firm.

Presence in sectors

This job position is present in 65% of the companies covered by this study.

It is considered essential in the current growing demand for personalized projects. The Technical office assistant are defined as contributors of specialized knowledge and with a strong vocation for innovation to translate the needs of the client into innovative and functional technical solutions. Its ability to apply new and creative solutions to product design and development challenges is critical to competitiveness in a demanding market.

General comments:

Functions vary based on products, technologies, and company size. In small companies, these roles may involve drafting plans, programming numerical control machines. Depending on the organization is some of those small company, multifunctional profile that integrates the purchase of raw materials, warehouse control, preparation of offers and dealing with the customer is also observed.

The professionals in this job position with a VET background are highly experienced workers, usually with an extensive experience in production that promote to the technical office.

In own product companies, product development and process engineering are separate departments, with technical office assistants typically aligned with product development. For companies where the main activity is the develop manufacturing and automation processes, the profile is related to these activities.

5.5.2. LEVERS OF CHANGE

This job position is classified as changing. The factors contributing to the change identified are the following:

- Product customizations, modifications and evolutions (own products)
- Product's complexity, increase of challenges for their manufacture
- Evolution of ERP systems. Increase of IoT, M2M communication and data acquisition systems
- Introduction of automations in the workstations
- Inclusion of multifunctional machines, in the case of machining, involving more complex numerical control programming.
- New manufacturing lines that include advanced technologies in their design.
- Related to sustainability, robotisation of the calculation of the carbon footprint and subsequent reduction actions.
- Increase the expansion to international customers. Higher interaction with customers.
- Systemic view of the process

- Working in multidisciplinary or interdepartmental teams

5.5.3. SKILLS AND COMPETENCIES

The emerging technical skills mentioned in the interviews for this job are:

- Analysis of production data, for those technical office also in charge of production management .
- Advanced CAD design. In some cases including (FEM) simulation of processes,
- CAM systems for those technical office in charge of production management in machining companies.
- Product Life Management (PLM) systems
- Energy efficiency of equipment
- Calculation and reduction of carbon footprint
- Cybersecurity
- Languages, mainly English and sometimes others such as French.

The transversal competencies match the general ones mentioned in, with special focus on communication skills, problem solving, including quick response to the customer.

Qualification requested for this job:

Usually to promote to this job the work experience is compulsory. The background could be diverse:

- Mechanical Manufacturing Design EQF5
- Production Scheduling in Mechanical Manufacturing EQF
- Double qualifications or Qualification + specialization courses are very much valued i.e.
    - Mechanical Manufacturing Design EQF 5 + Specialization Course in Smart Manufacturing
- Mechanical Engineering EQF 6
- Electronic engineering EQF 6
- Production management engineering EQF6

5.6. AUTOMATION TECHNICIAN

5.6.1. GENERAL DESCRIPTION

Numerical tool and process control programmer (ESCO 2514.4): "*Numerical tool and process control programmers develop computer programs to control automatic machines and equipment involved in manufacturing processes. They analyse blueprints and job orders, conduct computer simulations and trial runs"* (ESCO, n.d.).

This job position in related to the professionals that implement automations in productions lines or machinery to automatize tasks and or to acquire data coming from the equipment for its later processing. They also install the IoT systems and communication networks, integrating the automation with MES and ERP systems.

The functions assigned to automation technician overlaps with maintenance operator in many of the companies interviewed whereas in others those functions are carried out by personal in technical offices. In the analysed companies, Robot programming is part of the tasks of those professionals.

Presence in sector

The functions of automation are becoming relevant in all company interviews. However, the automation technician job position is present in only 40% of the companies interviewed, which are typically large companies with high levels of digital maturity. In the remaining companies, automation functions are integrated into other roles such as maintenance technicians or process engineering. In companies with proprietary products, automation embedded within the product is also handled by automation technicians.

According to one interviewed company, the key to the growth of this role is the cross-interrelation between processes, products, IT, and data acquisition. This job appears in companies that manufacture automotive parts, those that design automated processes, and those that integrate automation into their end-customer products.

This profile is increasingly present in factories. Sometimes it is linked to the product itself, which includes automations, and sometimes to the manufacturing process within the maintenance or process engineering function.

General comments:

In certain companies, this role is associated with maintenance, where the electrical and electronic components are becoming increasingly significant. The profile for this position is highly versatile, hence the analysis encompasses broad and general aspects.

5.6.2. LEVERS OF CHANGE

The main drivers of change for this job are the mentioned in section 5.1. Other aspects identified that may be very specific for concrete companies are:

- Development of specialized software for parameter setting
- Development of intelligent systems to reduce risks and facilitate product operation.
- Incorporation of elements linked to data acquisition, communications and digitalisation.
- Automation of present manufacturing processes, at different levels such as improvements including a welding robot, inclusion of AGVs, collaborative robotics, or entire manufacturing lines.

In the near future, companies plan to continue along the same lines and focus on:

- Evolving to more automation suppliers
- Opening up to new markets such as aeronautics.
- Increasingly complex and interconnected manufacturing systems.

5.6.3. SKILLS AND COMPETENCIES

The technical skills raising for the profile are highly representative of advanced manufacturing:

- Design of automatized systems
- Integration of IoT systems and systems management in digital environments
- Systems commissioning and start-up
- Knowledge in sensorics and industrial communication
- HMI, M2M communications
- PLC programming
- Robot programming
- Artificial vision
- Optimisation of processes using Artificial Intelligence
- Data analytics
- Assistance technologies for digital workplaces

- Cybersecurity

The transversal competencies match the general ones mentioned in **¡Error! No se encuentra el origen de la referencia.** with a special focus on continuous learning for constant updating in response to technological advances and problem-solving.

Qualification requested for this job:

Usually to promote to this job the work experience is compulsory. The background could be diverse:

- Production Scheduling in Mechanical Manufacturing EQF5
- Industrial Mechatronics EQF 5
- Automation & Industrial Robotics EQF 5
- Double qualifications or Qualification + specialization courses are very much valued i.e.
    - Automation & Industrial Robotics EQF 5 + Specialization Course in Smart Manufacturing
    - Automation & Industrial Robotics EQF 5 + Specialization Course in Artificial Intelligence and Big Data
- Mechanical Engineering EQF 6
- Electronic engineering EQF 6
- Production management engineering EQF6

5.7. QUALITY CONTROL ASSISTANT

5.7.1. GENERAL DESCRIPTION

Product quality controller (ESCO 7543.9): "*Product quality controllers check the quality of manufactured products. They work in manufacturing facilities where they perform basic inspection and evaluation of products before, during or after the production"* (ESCO, n.d.).

Presence in sectors

Quality control assistant positions are present in almost all the interviewed companies engaged in manufacturing activities (65%). However, they are not found in companies dedicated to automation.

This position is particularly relevant in so far as it relates to product quality and hence, knowledge on the product, customer's specifications, and sectorial standards.

General Comments:

Although the job position is not new, new functions are coming up due to the digitalization. Furthermore, functions traditionally carried out by the quality control department are switched to machine or line operators. It is observed a trend to integrate the control operations in all the companies as a part of the manufacturing operations. This allows the traceability of data related to critical components and operations. In those cases where the control process is being automated, a final human supervision remains.

5.7.2. LEVERS OF CHANGE

The changes affecting the job are already mentioned in 5.1:

- The implementation of more complex machines integrated into the company's data systems increases the number of controllable parameters.

- Capture of manufacturing parameters and their subsequent analysis. This requires knowledge of the complete process and in the analysis to establish the cause-effect relationship.
- Increased data collection for product traceability.
- Introduction of sensors in the manufactured products to automate their operation in automatic and autonomous environments.
- Evolution of the manufactured products, digitalisation of the monitoring of the products.
- New markets, new standards, new legislations, e.g. the manufacture of prostheses.
- Implementation of automatic measurements by machine vision systems.

5.7.3. SKILLS AND COMPETENCIES

Besides the skills linked to quality control assistant these other technical competencies have been observed. Note that they are very company dependant:

- Digital and management competencies
- General knowledge of lean manufacturing and 5S
- Data analytics and business intelligence systems
- Use of (digital) verification tools (3D scanners, artificial vision machines etc.)
- Cybersecurity
- Languages, especially English

The transversal competencies match the general ones mentioned in 5.1.8 with a special focus on communication skills to express ideas clearly and effectively, involvement and problem solving.

When asked about the training to be reinforced in new recruits, more general aspects appear such as the interpretation of complex drawings, digital skills for data analysis, languages, communication and some specific methodological problem solving (8D, 5Why, Isikawa).

Qualification requested for this job:

Usually to promote to this job the work experience is compulsory. The background could be diverse:

- Production Scheduling in Mechanical Manufacturing EQF5
- Industrial Mechatronics EQF 5
- Mechanical Engineering EQF 6
- Electronic engineering EQF 6
- Production management engineering EQF6

5.8. ASSEMBLY OPERATOR

5.8.1. GENERAL DESCRIPTION

The assembly operator job-position addresses both assembly line staff and machine assembly staff, depending on the company.

Industrial machinery assembler ESCO 8211.2: *Industrial machinery assemblers manufacture industrial equipment such as industrial robots, assembly line machines, and labeling machines. They use hand tools and computer-controlled machines.*

In this study, the assembly operator's role varies based on the company's organization, encompassing mechanical assembly, component assembly, adjustment and testing, as well as 'interior, exterior, and electrical and electronic brain assembly'.

Presence in sectors

The position is identified in 65% of the companies in the study and is valued as changing.

5.8.2. LEVERS OF CHANGE

It is observed that in companies engaged in the automation of operations and production lines, this profile has a very close relationship with the automation and maintenance profiles. Thus, the levers for assembly-automation- maintenance would be related to each other. Hereafter the levers related only to the assembly of the equipment are included. For the cases of automated equipment assembly other levers should also be considered.

- Automation of existing manufacturing processes, at different levels such as improvements including robots, inclusion of AGVs, collaborative robotics, or entire manufacturing lines.
- Digitalization of assembly workplaces, digital assembly instructions
- Implementation of assistance technologies, AR
- Digitisation and monitoring of products to be assembled and programmed
- Changes in environmental legislation (implication on recyclability).

More specific to assembly lines:

- Data collection in the assembly process
- New assembly processes according to equipment customization
- Digitalization of work environment including assistive technologies such as AGV and collaborative robots, new production lines
- Lean manufacturing

5.8.3.SKILLS AND COMPETENCIES

The evolving technical skills identified for the assembly operator are generic

- Digital competencies
- Lean manufacturing
- Ability to operate and understand assembly and control systems
- Identify and resolve technical obstacles either from the product or from the means of production that may arise during the manufacturing process

For machine assembly staff:

- PLC programming, robot programming
- Complex drawing interpretation
- Knowledge in sensorics and industrial communication
- HMI, M2M communications

The transversal competencies match the general ones mentioned in 5.18, with a special focus on communication skills, autonomy, problem solving and working in a collaboratively way with other team members to ensure smooth execution of the scheduled work.

Qualification requested for this job:

- Industrial Mechatronics EQF 5

- Automation & Industrial Robotics EQF 5
- Double qualifications or Qualification + specialization courses are very much valued i.e.
    - Automation & Industrial Robotics EQF 5 + Specialization Course in Smart Manufacturing

5.9. INDUSTRIAL ASSEMBLY SUPERVISOR - TEAM LEADER

5.9.1. GENERAL DESCRIPTION

Industrial assembly supervisor (ESCO 3122.3): "*Industrial assembly supervisors are in charge of organizing, planning and coordinating assembly operations. They keep track of all the work activities and manage the process for efficient functioning in order to tackle problems such as production loss. They answer to the industrial production and the manufacturing manager"* (ESCO, n.d.).

According to the interviews, in addition to the assembly line manager, the role of work teams coordinator is added to those included in the ESCO definition. This entails leading the execution of strategies within an area and implementing actions for its continuous improvement.

Presence in sectors

This job position is present in 65% of the companies. The team leader plays a key role in the efficient and cost-effective operation of the company to maintain high quality standards, meet delivery times and control production costs.

General comments:

The position is linked to the production department. The study of this position has focused on individuals with Vocational Training (EQF5) qualifications who begin their work as operators and progress to expert level. Additionally, the competencies listed in this section should be considered.

5.9.2. LEVERS OF CHANGE

It is defined as a highly evolved position.

The levers of change are linked to organizational level transformations, production challenges, and the demands of planning including the use of ERP/MES systems and data collection. In addition to the mentioned in section 5.1, the following are included as the most influential:

- Increased levels of versatility
- Increased autonomy in functions
- Increased customization of the products or equipment manufactured
- Participation in the implementation of improvements and in multi-purpose teams
- Inclusion of more complex technologies in the area

5.9.3. SKILLS AND COMPETENCIES

The technical competencies of this profile include:

- Expert knowledge of the product and the manufacturing process.
- Highly skilled in responding to changes in technology,

- Knowledge of lean manufacturing
- Languages, especially English.
- Cybersecurity in OT systems

The transversal competencies match the general ones mentioned in 5.1.8, with a special focus on leadership and management skills due to the relevance of the position

Qualification requested for this job:

Usually to promote to this job the work experience is compulsory. The background could be diverse:

- Production Scheduling in Mechanical Manufacturing EQF5
- Industrial Mechatronics EQF 5
- Automation & Industrial Robotics EQF 5
- Double qualifications or Qualification + specialization courses are very much valued
- Mechanical Engineering EQF 6
- Electronic engineering EQF 6
- Production management engineering EQF6

5.10. COLD FORGING OPERATOR

5.10.1. GENERAL DESCRIPTION

The closest definition found in the ESCO database for this job is s*tamping press operator*

Stamping press operator (ESCO 7223.21): "*Stamping press operators set up and tend stamping presses designed to form metal workpieces in their desired shape by applying pressure through the up and down movement of a bolster plate and a die attached to a stamping ram on the metal, resulting in the die producing smaller metal parts of the workpiece fed to the press"* (ESCO, n.d.).

The definition above refers to sheet metal forming technology, whereas cold forging operators work with bar or wire. This job appears in only one company interviewed but it serves as representative for a big concentration of cold forging companies placed in the Basque Country. Cold forging press operators set up multistage high speed progressive presses to produce complex part in up to 6 strokes by metal forging at room temperature including the preparation of the tooling sets.

The main sector for these companies is automotive. The digital transition is bringing the connections of machines and implementation of data acquisitions systems, integrating the machines production data with ERP systems. Servo drive presses and/or transfers systems are also contributing to increase the complexity of forming processes.

5.10.2. LEVERS OF CHANGE

- Increase in the complexity of produced parts.
- Retrofitting of presses
- Data acquisitions systems integrates to high-speed progressive presses.
- Chage in standards in the automotive sector as example traceability of produced components, high level of cleanliness, strict dimensional tolerances, zero errors.
- Trends toward the prognosis of tool break based on effort curves analysis by means of big data analysis.

5.10.3. SKILLS AND COMPTENCES

Cold forging press operators usually are trained in house being the work experience the key to get skilled operators.

Technical skills derived from digitalization are listed below.

- Data management, digital literacy, HMI interactions
- Relation between physical phenomena and digital signals.
- Traceability of components.
- Artificial vision systems for components control
- Cybersecurity in OT systems
- Knowledge on the full process

The mindset change is considered vital. Cold forging operators, in addition to producing components become responsible for the data associated with these products.

The transversal competencies match the general ones mentioned in 5.1.8, with a special focus of problem solving.

Qualification requested for this job:

- Production Scheduling in Mechanical Manufacturing EQF5
- Industrial mechatronic EQF 5
- Double qualifications or Qualification + specialization courses are very much valued
    - Production Scheduling in Mechanical Manufacturing EQF5 + specialization program in cold forging

5.11. OTHERS

This section completes the profiles named by fewer companies but rated as relevant.

5.11.1. WELDER

Welder ESCO 7212.3: "*Welders operate welding equipment in order to join metal workpieces together. They can use fusion welding processes based on different techniques and materials. They also perform simple visual inspection of welds"* (ESCO, n.d.).

In companies where welders are employed in-house, their primary role involves working with large parts or structures, which includes handling loads.

Levers of change

This job is considered as little changed in the last five years, and present in 35% of companies.

It requires specialized skills, interpretation of drawing and quality assurance for each weld. Companies follow a certification procedure that allows them to ensure, together with a recognised qualification, to demonstrate technical and professional capacity.

The main lever of change is the incorporation of welding robots, foreseen in two companies.

Skills and competencies

Among the technical competencies listed for the welder profile, there are some more specific ones such as the integration of laser welding and others that comprise more general aspects such as:

- Adaptation to new measurement and verification systems:
- Use of digital equipment for drawing interpretation:
- Emphasis on quality and accuracy
- Human-robot interaction

Transversal skills include the development of communication skills and involvement.

5.11.2. TECHNICAL SALES REPRESENTATIVE

Technical sales representative ESCO 2433.6: "*Technical sales representatives act for a business to sell its merchandise while providing technical insight for customers"* (ESCO, n.d.).

Level of change

The drivers of change have to do with keeping up to date with technological developments in the market and the product customization that comes with the technification of the profile.

As a consequence of the trend towards the expansion of customer service, in the positions occupied by VET profiles, in some cases there is a tendency for the competencies to shift towards the profile of a project manager.

Levers of change

The manufacture of new products and the inclusion of advanced technologies influences the job profile and attributes to it a high need for knowledge to establish the reliability of equipment.

Skills and competencies

Technical competencies related to the specific profile:

- High technical knowledge of the process about and the ability to understand and communicate technical and advanced aspects of manufacturing products or services, as well as their applications and benefits to customers.
- Customer-centric attitude, with the ability to understand the specific needs and challenges of each customer in the advanced manufacturing sector and deliver customized solutions that add value to their business.
- Focus on innovation and continuous improvement.

The competencies defined are related to transversal competencies and have an impact on analytical and problem-solving skills communication and languages.

5.11.3. INJECTION MOULDING MACHINE OPERATOR

Moulding machine technician ESCO 7233.12: "*Moulding machine technicians service machinery used in the casting and moulding of plastics and other materials. They calibrate the equipment, perform maintenance activities, examine finished products and repair faults"* (ESCO, n.d.).

In addition to the ESCO functions, mould changing and injection moulding parameter control are also available.

Levers of change

- Automation and integrated robotics to improve efficiency and productivity. This includes the integration of robots for part handling, automatic assembly and material loading and unloading.

- Advanced process control allowing greater control over the moulding process. This includes the ability to monitor and adjust parameters such as pressure, temperature and injection speed in real time, ensuring greater accuracy and quality of moulded parts.

Skills and competencies

Technical competencies related to the specific profile:

- Understanding of the control systems and being able to adjust parameters to optimise the manufacturing process.

Regarding transversal competencies, emphasis is placed on adaptability. continuous learning and problem solving.

6. EXPERTS' VALIDATION

The findings of the report were discussed with a committee of expert in fields related to advanced manufacturing and or VET. This section summarized the comments and suggestion given by the groups during a face to face workshop carried out the 29th of April 2024 at Tknika.

Participants:

- **Rikardo Lamadrid**, Basque Education Ministry, Director of technologies and advanced learning
- **Iñigo Araiztegui**, Director of Internationalization department, Tknika
- **Susana Espilla**, project manager at the internationalization department, Tknika
- **Mikel Albizu**, Researcher at Orkestra, Basque institute of competitiveness.
- **Josune Irazabal** Expert on Basque VET, Manager of digitalization at CIFP Miguel Altuna.
- **Josu Riezu** Director of people department. AFM , Cluster of Spanish Machine tool manufactures
- **Ricardo Alberdi**, representant of Ikaslan Bizkaia. Association of Basque public VET Centres
- **Isidro Zaldua** representant of Ikaslan Gipuzkoa. Association of Basque public VET Centres
- **Uribarri Goikuria,** Project manager at Innobasque, Basque innovation agency,
- **Oriol Homs,** Expert on Spanish VET, sociologist, author of one of the reports included in our analysis (online)

About the study methodology

The analysis methodology and the sample used are considered appropriate. To add quality and representativeness to the sample, it is recommended to:

- Include leading companies with high levels of digitalization maturity.
- Include technological companies or startups.
- Consider other sources of information, such as Lanbide job employment data.

On the other hand, the difficulty of conducting comparative analyses considering the difference in digitalization levels among companies is reaffirmed. Consequently, analyzing occupations that are highly dependent on these levels of digitalization is complex. The same issue arises at the European level when discussing competencies and skills.

It is suggested that in the policy briefs of LCAMP, a recommendation be drafted to the European Commission regarding the need to define standards, both for skills and digitalization

Digital and green transformations

The report mentions:

- The dependency on organizational factors for the competencies attributed to each position.
- The heterogeneity in the pace of transformation.

Regarding how occupations and vocational training titles should be related, several comments arose:

- These factors often result in a lack of direct correlation between vocational training titles and job positions. Therefore, creating curricula that specifically match certain positions is very complex. Typically, companies hire individuals with a range of skills and versatility, and then, after internal training, they are placed in specific positions according to their abilities. Additionally, there is rotation to other positions. This situation raises questions about the value of generating specific curricula for particular positions. What does appear relevant is understanding the competencies required for occupations in different types of companies and what factors influence those competencies.

Regarding the pace of digitalization, it is noted that idustries are at the beginning of the digital transformation. Companies (in general) view digital transition as an opportunity to improve profitability and/or management. However, sustainability is perceived in many cases as a "regulatory imposition" that creates difficulties, especially when competing with companies not subject to similar regulations. This difference in perception also affects how both transformations are approached and, consequently, the competencies of individuals.

Technology adoption

The standard digitalization sequence identified, which consists of data capture, equipment and process monitoring, and automation, aligns with the experience of the focus group members.

Additionally, regarding the assertion that the difference in transformation level is mainly marked by the size of the company, the focus group confirms this finding from other studies. The relevance of proprietary products is also noted, with customers often driving innovation in these cases.

Evolution of Job Positions

The conclusions of the report regarding the evolution of occupations are corroborated by the focus group: traditional occupations are not disappearing, although they are being assigned functions that were traditionally assumed by other profiles. Versatility is established as a very important attribute in all occupations.

Regarding the changes undergone by the analyzed job positions in the sample companies, maintenance technicians and SAT (Technical Assistance Service) technicians have been the most affected. The focus group participants have viewed these comments positively.

The report mentions the low presence of technologies such as AI, VR/AR, digital twins, 3D printing, and even robots in the analyzed positions. Several comments have emerged in response to this assertion:

- Technologies like AI, VR, DT, etc., may be present in newly established technological companies that indeed require such profiles.
- A possible reason for companies not recognizing the need for new profiles in AI, VR, DT, etc., could be that these functions are outsourced. (Hypothesis to be verified)

- It's possible that some of the more technologically advanced functions (AI, digital twins, data analytics, etc.) are carried out in some companies by profiles not studied (engineering, R&D, etc.). (Hypothesis to be verified)

The group of experts confirms the existence of high-level technology service providers in AI, DT, VR, data analytics, etc., who work for advanced manufacturing companies and indeed require qualified individuals. It seems reasonable to think that as manufacturing companies internalize these types of functions, the need for such competencies will increase. (Hypothesis to be verified.

Competences

Some interesting comments have emerged in this section:

- The process of professionalization is changing, and the relationship between competencies acquired in VET centres and in companies is evolving. Specialization occurs within the company, while a strong technological foundation is expected from VET centres.
- The balance between basic competencies and specializations is key. There is a debate about what should be taught in the basic part, to what extent centres specialize, and how professionalization is structured throughout life, whether within the company or in collaboration with training centres.
- Specializations can also have levels, for example, basic specialization in AI, advanced specialization in AI, etc.
- Standardizing curricula is mentioned as an obstacle since we are in a transition where each company progresses at its own pace. However, non-standardization is very complex. Standardization to a certain extent with flexibility to adapt to different realities is an option worth exploring.

Regarding how VET centres are perceived as providers of specialized profiles:

Companies are demanding high levels of specialization for their processes, but often do not see VET centres as providers of such specializations. This is a gap we have in vocational training: VET centres offer specialization courses, but companies still do not identify those specialized profiles with vocational training. VET students do not (yet) cover those profiles, often due to unawareness of the capabilities of these students. There is work to be done by the vice-ministry, the centres, and the companies in this regard.

Furthermore, the lack of common terminology between companies and education, and even between educational systems in different countries, is mentioned. As a result, even being able to accurately define competencies does not solve the perception problem. There is a lack of understanding of the real capabilities attributed to specific qualifications; some companies tend to over-qualify positions, meaning they select a profile such as an engineer to fill a position defined for VET.

Usefulness of the report

VET- ministry, policy makers

This type of study helps us better understand professional profiles and their evolution.

- It is necessary needed to better understand the causes of aspects mentioned here, such as how specializations are perceived in some companies.
- It may be interesting to organize forums to analyze this type of report, by regions, sectors, stakeholders, etc., to draw conclusions and facilitate decision-making in different aspects such as curriculum development, among others.

Vocational Training Centers:

- The findings allow us to keep us grounded and understand reality beyond our immediate environment. They help us make decisions and verify information obtained from other sources to ensure that the information coming from different sources is accurate.
- It is also advisable to conduct critical analysis and share insights in forums like this to compare the conclusions of many published reports. Sometimes we do not see ourselves reflected in what some reports say.
- They serve to show teachers the situation of companies.
- The report help us to determine if our strategy responds to reality, to see if the adaptations in the courses are adequate, etc.

General

The report is useful to generate debate among centres, companies, social organizations, institutions, etc., to reflect and mature on how the vocational training system needs to change.

Additional considerations

The study mentions that, in the sample studied, the main driver for companies' digitalization is increased competitiveness, ahead of employee well-being. In response to this assertion, it is noted that regional studies underline the central role of people in business development. Therefore, this could be a point of reflection.

The study shows that we are in a context where a cultural and organizational change is needed ahead of purely technological change.

Another suggestion is to include the opinions of social agents and unions in these types of studies. It may happen that some companies or groups of companies lobby to prioritize curricula related to their particular activities. However, there is a growing need for more versatile profiles in vocational training.

A key aspect could be to give VET centres greater autonomy to flexibilize the curriculum according to their regional context, as allowed by law. This type of measure would allow for the creation of non-standardized specialization courses, tailored to the demands of companies with well-contrasted quality criteria (timing, format, etc.), with more flexible contents.

Finally, a widespread comment is that debates like the present one with groups of experts are of great interest for addressing relevant topics for vocational training and its stakeholders.

Jobs analysed related to VET titles.

Following a comment of one participant, the table below shows the relations between the jobs included in the report and the most common VET titles requested for them. Note: the table does not include specialization courses, as establishing such a relationship requires a more detailed description of the functions related to jobs. This work is open for future analysis.

Table 7 Analyzed jobs and related VET titles.

	VET titles	EQF5	EQF5	EQF5	EQF5	EQF5	EQF4	EQF4	EQF4
		Production Scheduling in Mechanical Manufacturing	Industrial Mechatronics	Automation & Industrial Robotics	Design in Mechanical Manufacturing	Metallic constructions	Machining technician	Electro mechanical maintenance	Welding
	JOBS								
1	CNC technician (Operator + programmer)	1	2		2		1		
2	Maintenance Operator (electrical, mechanical and others)	2	1	1				1	
3	After Sales Service technician-TAS operator (electrical, mechanical and other)	1 + 3	1 + 3	1 + 3	2 + 3				
4	Technical Office assistant (mechanical, electrical, product development and other)	2	2	2	1				
5	Automation technician & Robotics	2	1	1	2				
6	Quality Control assistant	1	1	2	1				
7	Assembly operator	1	1	2	2		1	1	
8	Industrial Assembly Supervisor	1	1	1	2				
9	Cold forging operator	1*	2*		1*				
10	Welder					1			1
11	Technical Sales representative	1 + 3	1 + 3	1 + 3	1 + 3				
12	Moulding machine technician	1			1				

Used nomenclature:
1= First choice
2= Second choice
3= work experience compulsory
*= preferably with specialization programs

Figure 7 Workshop with the Basque validation groups with representatives of industry, education and government.

7. CONCLUSIONS

This study examines the progression of advanced manufacturing employment within the Basque country, spurred by digital transformation. Data pertaining to the evolution of 12 job categories across 17 companies have been compiled. Augmenting this primary research endeavour are findings from other organizations' studies conducted within advanced manufacturing enterprises between 2019 and 2023. Notably, insights gleaned from reports by AFM (surveying 19 companies in 2022), CEX-FA (interviewing 8 companies in 2023), and Innobasque (surveying 19 companies in 2019) have significantly contributed to this paper, with data from a cumulative 57 companies being integrated.

The results of LCAMP's study closely align with those of the analysed reports, occasionally offering supplementary insights, duly acknowledged. The analysis underscores the transformative impact of digitization and sustainability initiatives on job roles within companies. Our study corroborates the findings of the other analysed reports. Consequently, we have drawn conclusions regarding the nature of this transformation.

Transformation of jobs

The evolution of jobs is intricately tied to the industrial context, influenced by various factors such as company size, digital maturity, production types, business strategies, organizational culture, regulations, and more. This aligns with the notion that "organizational factors exert the greatest influence on workforce skill development" (Homs, 2023). Indeed, the analysis reveals that the evolution of certain jobs can vary significantly depending on the company. The pace of digitization distinctly shapes the extent of job transformation.

Primarily, digital transformation aims at enhancing company performance, with less emphasis placed on the well-being of individuals as the primary driver of change. However, it's widely acknowledged that the involvement of people is crucial in implementing these changes. As AFM states,

The impact of transformation extends across all job categories examined in this report, albeit with varying degrees of significance. Only in rare instances, substantial shifts are found, where the very nature of tasks linked to a job undergoes complete transformation. Generally, digitization reshapes job structures or specific tasks within them, consequently influencing staff functions in alignment with CEX-FA and AFM. Moreover, this evolution introduces new responsibilities to workers who previously did not encounter them. All companies agree that the workers should be versatile, with a flexible mentality to change, with an interest in learning, ability to communicate effectively and solve problems.

Not many new jobs have been identified, and those mentioned are those related to data analytics in large companies. The jobs that have undergone major changes are maintenance (in some cases), TAS and automation (in some cases).

Drivers for transformations

In general, digital transformation has as its main objective to improve company performance. The well-being of people has rarely been mentioned as the main cause of change, although, of course, everyone insists on the absolute importance of people in carrying them out. New organizational models are taking place as companies are becoming aware of the key role of the workforce to success in their digital transformations. Yet few mechanisms are observed to empower the workforce to enhance their participation.

Organisational changes as a consequence of the digitalization are envisaged, as to provide more autonomy to all the levels of the company. Data-driven management is being strongly promoted. New working methods and organizational models are taking place.

The companies interviewed, encouraged by digitalisation, demonstrate a trend towards market adaptation and the customization of products and services to enhance competitiveness. In same cases they notably include emerging markets with reference to renewable energies and, to a lesser extent, to health. These trends coincide with AFM's assertions.

Technologies

Data collection and system integration are the basis for change in jobs. The most widespread technologies are related to machine and process monitoring, integration of MES and ERP systems. As well as access to data associated with inspection and measurement systems, i.e. the incorporation of systems aimed at monitoring and traceability of the entire value chain of the product. The integration of these systems is accelerated by the introduction of multifunctional machines, retrofitting of existing machines and automation of production lines.

There is also a growing demand for process data collection and for making it available to customers both on the product being manufactured and after the product has been delivered to the customer. These assertions are aligned with the technologies identified as priorities by companies in the Basque Country according to Innobasque (2019).

Interviewed companies, regardless of their size, mention ongoing projects using language that encompasses intelligent systems, manufacturing process automation, digitization, data collection, IoT systems, and, looking ahead, they delve into the realm of AI and augmented reality (although the latter is less prevalent currently). These trends align with the findings of the report "Identification of training needs for the preparation of job profiles in the automated manufacturing sector" (Homs, 2023).

Remarkably, companies with proprietary products encompass a broader scope of Industry 4.0 technologies. Digital transformation is not only applied to their production processes but is accentuated by endowing their products with digital features/functions and by offering digital services related to their operations. Endowing products and services with such characteristics demands a substantial technological leap for these companies, consequently requiring an enhancement in the competencies of individuals. Functionalities associated with IoT systems, communications, and data utilization provide opportunities to monitor product operations and enhance preventive maintenance. Some companies are evaluating the use of augmented reality and virtual systems to facilitate remote learning and work.

Artificial intelligence, 3D printing, digital twins and the use of robots deserve special mention: Although AI remains a topic of discussion, it has yet to be fully integrated into the companies under study, although short-term implementation plans for AI have been observed. 3D printing is recognized as a task associated with other roles within the companies. With regard to the use of robots, despite the automation trend detected within the analyzed companies, there is less emphasis on incorporating robots directly. The interviewed companies have not yet adopted digital twins. The level of adoption of these technologies reflects a similar pattern to the data provided by Eustat (EUSTAT, 2023).

Sustainability

Climate emergency measures are more prevalent in large companies, including actions such as automating the calculation of carbon footprints, improving the energy efficiency of manufacturing equipment and buildings, and eliminating certain greenhouse gases. It is noted that this process is in its early stages and that there is still a long way to go**.**

Competencies

Companies seek highly specialized profiles tailored to their manufacturing processes. This specialization is developed through in-house training and work experience, built upon the foundational knowledge acquired by individuals from VET schools. Thus, VET profiles are expected to possess a solid understanding of the fundamentals, along with proficiency in computer/digital skills and languages, complemented by robust transversal skills. Among these, the most frequently mentioned include problem-solving abilities, analytical thinking, a proactive learning attitude, effective communication, and a strong sense of engagement.

As observed in the study, VET industrial programs are the main source for the analysed jobs, notably leading to higher-level degree programs (EQF5) such as mechanical manufacturing, mechatronics, industrial automation & robotics, and manufacturing design. Versatility is a highly valued attribute that emerges frequently in many interviews. In terms of versatility, individuals with dual qualifications, such as mechanical manufacturing coupled with automation and robotics, are regarded favourably. Specialization courses within VET have also received positive evaluations in the instances.

Training programs within the company are widespread among the interviewed firms. Typically, these initiatives are focused on addressing immediate production requirements, signifying a gradual progression rather than a disruptive change. Concerning the training content, while companies appreciate both personal and technical competencies, they give precedence to technical skill development. Companies aim for individuals to possess personal skills inherently, considering them as foundational.

Dual training and internships, developed in collaboration with VET centres, are highly regarded as valuable resources. On one hand, companies provide students with hands-on training tailored to their specific processes, complement official learning programs. On the other hand, this approach enables companies to attract and retain talent while also assessing students' suitability for future roles.

Dual and in-company training

In terms of hiring, companies have difficulty attracting talent. It should be noted that in some companies interviewed, due to the shortage of personnel, automation is conceived not only as a means to increase performance but also to reduce the need for personnel.

Regarding the aging population, its impact is particularly negative for small businesses, as younger individuals tend to seek out more technologically advanced environments and more comfortable working conditions.

The gender gap persists as a significant issue. Among the companies interviewed, 73% provided data regarding their workforce segregated by gender. Women constitute 27% of the total number of VET graduates among their staff.

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10. INDEX OF IMAGES

Figure 1 Share of organizations surveyed which consider skills to be core skills for their workforce Source World Economic Forum, Future of Jobs Survey 2023 (WOF, 2023, p. 38). 11

Figure 2 Transformation priorities/challenges in which companies are currently preoccupied with Source (AFM, 2022)..... 13

Figure 3 Digital transformation initiatives and priorities/challenges in which companies are moving towards Industry 4.0 (AFM, 2022)..... 13

Figure 4 Size of the companies..... 18

Figure 5 VET centres involved in the analysis. 19

Figure 6 Interview's process..... 19

Figure 7 Workshop with the Basque validation groups with representatives of industry, education and government..... 46

11. INDEX OF TABLES

Table 1 Indicators of Industry 4.0 in the industrial establishments of the Basque Country according to employment stratum (% of establishments) 2022. Date July 12, 2023. Source: (EUSTAT, 2023) 10

Table 2 Expected recruitment for the next 5 years among the 19 companies surveyed (AFM, 2022) 14

Table 3 List of jobs analysed in the report 16

Table 4 List of companies participating in the study 17

Table 5 List of VET centres involved in the study 19

Table 6 Jobs analysed in companies 25

Table 7 Analyzed jobs and related VET titles. 46

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