METIS

Deliverable 2.2 – Annex 2

Co-funded by the
Erasmus+ Programme
of the European Union

METIS
Co-funded by the Erasmus+ Programme of the European Union

Microelectronics Training, Industry and Skills (METIS) project number 612339-EPP-1-2019-1-DE-EPPKA2-SSA-B under the action Sector Skills Alliances in vocational educational education and training Grant Agreement number 612339-EPP-1-2019-1-DE-EPPKA2-SSA-B

Annex 2

Table of Contents

Annex 2 – Other occupational blueprints: Detailed description of key microelectronics job profiles

Chapter II) C) 2) a) describes the occupational blueprints of the 5 most critical job profiles identified.

The occupational blueprints of the other job profiles studied are described in this annex.

Profiles are ranked by order of criticality.

1) ASIC Architect designer

Occupational blueprint
An ASIC architect is a sub-profile of System designer.

Number of stakeholder(s) involved in the design of the occupational blueprint: 1

It requires many years of ASIC Design to become an ASIC architect designer. The associated skills and are hard to teach without practical work. Defining architectures requires industry experiences.

	Entry / Junior Level	Mid-level	Senior level
Seniority of profiles recruited in the next 12 months	0%	20%	80%
Level of difficulty to find skilled candidates on a scale of 0 to 10 (10 is the maximum)	10/10	10/10	10/10
Average duration to fill a vacant position	Infinite	>9 months	> 1 year
Average duration of the training of new hires till they become productive	>5 years	3-5 years	1-2 years
Minimum educational level	EQF 7 EQF 8 is a most		EQF4
Estimated percentage of the workforce requiring upskilling	50%		

Most common field of study		Field of study of the workforce
1	Most common	- Physics - Mathematics
2	Less common	- Software engineering - Mechatronic - Microelectronic engineering - Information and computer engineering - Electromechanical engineering
3	Even less common	- Information technology - Biomedical engineering

4	Rarest	- Chemistry - Advanced material science

Skills that are both the most needed and the most challenging to find

i. Level of difficulty to find the skill on a scale of 0 to 10 (10 is the maximum)
ii. Importance of the skill on a scale of 0 to 10 (10 is the maximum)
iii. Comments

The minimum educational level required for ASIC architect designers' candidates at the entry level is EQF 7. Therefore, the skills described below must be acquired once students reach the EQF level 7.

N°	Skill	Questions	Entry Level	Mid-Level	Senior level
1	MEMS sensor/ transducer principles: Inertial SiP	i	10	10	10
		ii	0	10	10
		iii			
2	Sensor ASIC development: ASIC partitioning, architecture and interaction	i	10	10	10
		ii	0	8	10
		iii	Hard to teach without practical work. Typical item for PhD's		
3	Sensor ASIC development: ASIC digital design and backend	i	10	8	9
		ii	0	8	10
		iii	Design, Tooling and Method skills needed		
4	MEMS sensor/ transducer principles: Environmental SiP (gas, humidity, pressure)	i	10	10	10
		ii	0	8	8
		iii			
5	MEMS sensor/ transducer principles: Optical SiP	i	10	10	10
		ii	0	8	8
		iii			
6	Sensor ASIC development: ASIC analog/mixed signal design	i	10	8	8
		ii	0	10	10
		iii	Needed for many companies. Availability limited		
7	Customer Systems and Applications: Hardware and solution engineering	i	10	9	8
		ii	0	8	8
		iii	Good costumer reputation needed as architect		
8	Production Processes: ASIC Production Processes	i	10	8	10
		ii	0	7	8
		iii	Typically worded already in Fabs or Labs. Local limitations due to limited Fab availability		
9	MEMS sensor/ transducer principles: Magnetics SiP	i	10	10	10
		ii	0	5	7
		iii			

10	MEMS sensor/ transducer principles: Measurement technologies ("Messtechnik")	i	10	7	9
		ii	0	7	8
		iii	Only a few companies really have MEMS in their portfolio. Just a few senior experts worldwide available.		
11	Sensor SW development: (algorithm development and digital) Signal processing CE sensors	i	10	8	8
		ii	0	7	7
		iii	Design, Tooling and Method skills needed		
12	Customer Systems and Applications: Product application regarding Use case (drones, indoor navigation, pico projection, etc.)	i	10	8	8
		ii	0	6	6
		iii	With passion possible to adopt		
13	Customer Systems and Applications: System Test	i	10	7	7
		ii	0	7	7
		iii	Out of engineering and ramp up test experience		
14	Customer Systems and Applications: Test Automation	i	10	7	7
		ii	0	7	7
		iii	Out of engineering and ramp up test experience		
15	Production Processes: ASIC Production Processes	i	10	8	10
		ii	0	7	8
		iii	Typically worded already in Fabs or Labs. Local limitations due to limited Fab availability		
16	Production Processes: Companies' Production Systems	i	10	6	8
		ii	0	6	6
		iii			
17	Quality Competences: Generic Quality Competences	i	10	6	8
		ii	0	6	6
		iii			
18	Methods and Processes: Illustration of technical data	i	5	5	6
		ii	5	5	5
		iii	Technical vocabulary needed. This knowledge is already easy to find in the workforce currently		
19	Methods and Processes: Product engineering & production methodology	i	5	5	6
		ii	5	5	5
		iii	Technical vocabulary needed. This knowledge is already easy to find in the workforce currently		
20	Methods and Processes: Compliance	i	5	5	6
		ii	5	5	5
		iii	This knowledge is already easy to find in the workforce currently		

Foresight exercise: The three skills that will gain the most importance by 2025 for this profile

N°	Name of the skill	Description
Skill 1	Sensor and SoC ASIC development: ASIC partitioning, architecture and interaction	More complex ASICs are required in future. From Sensors up to SoC (System on Chip)
Skill 2	Sensor SW development: (algorithm development and digital). Signal processing	Hardware Software partitioning needed in future with break down also on microcontroller vs DSP (Digital Signal Processing) optimizations
Skill 3	MEMS sensor/ transducer principles: Inertial SiP	-

2) ASIC Analog designer

Occupational blueprint
An ASIC analog designer is a sub-profile of analog designer.

Number of stakeholder(s) involved in the design of the occupational blueprint: 1

Many ASIC analog designers are needed by the European microelectronics industry for many different products (Sensors, Power, References, Auxiliary blocks, etc.).

	Entry / Junior Level	Mid-level	Senior level
Seniority of profiles recruited in the next 12 months	15%	35%	50%
Level of difficulty to find skilled candidates on a scale of 0 to 10 (10 is the maximum)	5/10	8/10	10/10
Average duration to fill a vacant position	>3 months	>6 months	>9 months
Average duration of the training of new hires till they become productive	3 to 5 years	1 to 2 years	3 to 6 months
Minimum educational level	EQF 7 EQF 8 is a plus		EQF4
Estimated percentage of the workforce requiring upskilling	20%		

Most common field of study		Field of study of the workforce
1	Most common	- Electromechanical engineering - Physics
2	Less common	- Information and computer engineering - Information technology - Mechatronic

		- Mathematics - Software engineering - Biomedical engineering
3	Even less common	- Chemistry - Advanced material science

Skills that are both the most needed and the most challenging to find

i. Level of difficulty to find the skill on a scale of 0 to 10 (10 is the maximum)

ii. Importance of the skill on a scale of 0 to 10 (10 is the maximum)

iii. Comments

The minimum educational level required for ASIC analog designers' candidates at the entry level is EQF 7. Therefore, the skills described below must be acquired once students reach the EQF level 7.

N°	Skill	Questions	Entry Level	Mid-Level	Senior level
1	Sensor ASIC development: ASIC partitioning, architecture and interaction	i	10	10	10
		ii	5	8	10
		iii	Mechanical, chemical and electrical mix needed	Typical item for PhD's	Mainly via competitors
2	MEMS sensor/ transducer principles: Inertial SiP	i	6	8	10
		ii	6	10	10
		iii	A few universities really teach MEMS frontends	Only a few companies really have MEMS in their portfolio	Just a few senior experts available worldwide
3	MEMS sensor/ transducer principles: Environmental SiP (gas, humidity, pressure	i	6	8	10
		ii	6	10	10
		iii	A few universities really teach MEMS frontends	Only a few companies really have MEMS in their portfolio	Just a few senior experts available worldwide
4	MEMS sensor/ transducer principles: Optical SiP	I	7	8	8
		ii	7	8	8
		iii	A few universities really teach MEMS frontends	Only a few companies really have MEMS in their portfolio	Just a few senior experts available worldwide
5	MEMS sensor/ transducer principles: Magnetics SiP	I	6	8	10
		ii	5	8	8
		iii	A few universities	Only a few companies	Just a few senior experts

			really teach MEMS frontends	really have MEMS in their portfolio	available worldwide
6	Sensor ASIC development: ASIC verification	i	7	8	8
		ii	6	8	8
		iii	Design, Tooling and Method skills needed	Typically, out of many years of ASIC Design	
7	Production Processes: ASIC Production Processes	i	7	8	10
		ii	5	7	8
		iii	Chemical lessons needed	Typically worded already in Fabs or Labs	Local limitations due to limited Fab availability
8	MEMS sensor/ transducer principles: Measurement technologies (“Messtechnik”)	I	5	7	8
		ii	6	8	8
		iii	Measurement principles are taught in universities, but not the needed tooling on testers	Only a few companies really have MEMS in their portfolio	Just a few senior experts available worldwide
9	System Level HW: Optical and thermal design	i	7	7	8
		ii	5	7	7
		iii	Some PhDs have this skill	Real application experiences needed	
10	Sensor ASIC development: ASIC analog/mixed signal design	i	5	8	8
		ii	8	10	10
		iii	A few universities really teach analog design in expert level	Needed for many companies. Availability limited	
11	Sensor ASIC development: ASIC mixed signal test engineering	i	5	6	7
		ii	6	8	8
		iii	Measurement principles are taught in universities, but not the needed tooling on testers	Good in case of tooling experiences on testers	Typically, out of many years of ASIC Design
12	Customer Systems and Applications: Product	i	7	6	6
		ii	6	6	6

	application regarding Use case (drones, indoor navigation, pico projection, etc.)	iii	Personal motivation needed		
13	Methods and Processes: Compliance	i	8	6	
		ii	5	5	
		iii	Already good on company level		
14	Sensor ASIC development: ASIC Layout	i	4	6	6
		ii	5	6	6
		iii	-	-	-
18	System Level HW: PCB design and layout for CE	i	4	5	5
		ii	5	5	5
		iii	-	-	-
16	System Level HW: Mechanical design (incl. housing)	i	6	6	8
		ii	5	6	7
		iii	More mechanical skills needed	More mechanical skills needed but good also with electrical skills	
15	Methods and Processes: Illustration of technical data	i	5	5	6
		ii	5	5	5
		iii	Technical vocabulary needed	Designers can adopt this	Application and reliability knowledge needed
17	Methods and Processes: Innovation management	i	5	5	5
		ii	5	5	5
		iii	Already good on company level		

3) Digital design engineer

Design engineer (EQF 7) specialized in digital design. A digital design engineer creates the required design and related documentation of the relevant design area (digital design) in order to contribute to the achievement of the projects' targets in terms of product specification, cost, quality and timing.

Digital design engineers are also among the 5 most wanted job profiles today for within the semiconductor design business (Focus group organized by METIS on Semiconductor design). Several stakeholders report only a few skilled candidates on the European job market.

The knowledge and skills identified as often lacking to candidates are standard flow for digital design, synthesis, static timing analysis, place and route, UVM and System Verilog for digital verification, etc.

Several companies report using vocational internal or external trainings for their new hires.

Occupational blueprint

Representativeness of stakeholders involved in the design of the occupational blueprint	
Number of stakeholder(s)	Focus group on semiconductor design

Minimum educational level to be hired: EQF 7

Skills that are both the most needed and the most challenging to find at the entry level.

The minimum educational level required for digital designers' candidates at the entry level is EQF 7. Therefore, the skills described below must be acquired once students reach the EQF level 7.

N°	Skill	Difficulty to find the skill (in percentage of answers)		Importance of the skill (in percentage of answers)	
Mandatory knowledge / skill					
1	**Concept/ Top Level Design.** Knowledge of specific methods and tools to implement models for building blocks present in low to medium complexity projects: Have conceptual knowledge of the full project, including sensor models. Have a detailed understanding of digital design techniques and memories. Know the requirements for digital design regarding testability, coverage, timing, … Able to perform risk assessment on Analog-to-digital interface. Proficient with analogue and digital electronic design, RF design, power supply design, knowledge in analytical tools such as ETAP, schematic, spice simulation.	Not needed	0%	Not needed	0%
		Easy to find	0%	Fairly important	0%
		Difficult to find	0%	Important	0%
		Very difficult to find	**100%**	**Very important**	**100%**
2	**Top Level Simulation.** Creation and optimization (i.e., Simulation time...) of models needed for top level mixed signal verification. Create testbenches needed for full chip validation. Assessment of the functionality of the analog/digital interface.	Not needed	0%	Not needed	0%
		Easy to find	0%	Fairly important	0%
		Difficult to find	0%	Important	0%
		Very difficult to find	**100%**	**Very important**	**100%**

	Able to assess the testability of the design: knowledge of MMF, ATPG, delay test, scan chain... Able to create supporting blocks and dedicated stimuli files needed for top level validation				
3	**Design Implementation.** Able to build the top-level schematic, integrating the digital and the analog. Able to keep the documentation/specification up to date with the actual implementation. Know and follow guidelines regarding naming, hierarchy, design checklists … to assure efficient design reuse. Knowledge of advanced cadence simulations. RTL coding, HW description language (VHDL, Verilog, System Verilog). Scripting, digital verification flows and tools, IC design tools (e.g., Cadence)	Not needed	0%	Not needed	0%
		Easy to find	0%	Fairly important	0%
		Difficult to find	0%	Important	0%
		Very difficult to find	**100%**	**Very important**	**100%**
4	**Design Review.** Able to present the performed mixed signal simulations during the design review	Not needed	0%	Not needed	0%
		Easy to find	0%	Fairly important	0%
		Difficult to find	0%	Important	0%
		Very difficult to find	**100%**	**Very important**	**100%**
5	**Layout and back annotation.** Knowledge of influence of layout parasitics on mixed signal simulations (i.e., digital back annotation…). Able to support layout integration of the digital	Not needed	0%	Not needed	0%
		Easy to find	0%	Fairly important	0%
		Difficult to find	0%	Important	0%
		Very difficult to find	**100%**	**Very important**	**100%**
6	**Power management innovations.** Conversion, power harvesting solutions, etc.	Not needed	0%	Not needed	0%
		Easy to find	0%	Fairly important	0%
		Difficult to find	**100%**	Important	0%
		Very difficult to find	0%	**Very important**	**100%**
7	**Communication protocols.**	Not needed	0%	Not needed	0%
		Easy to find	0%	Fairly important	0%

	Knowledge in communication protocols/hardware interface, such as RS232, RS485, CAN Ethernet, USB, SPI, I2C, Flash, EEPROM, ADC/DAC, WiFi/Bluetooth	**Difficult to find**	**100%**	**Important**	**100%**
		Very difficult to find	0%	Very important	0%
8	**Design for Test (DFT) Techniques.**	Not needed	0%	Not needed	0%
		Easy to find	0%	Fairly important	0%
		Difficult to find	**100%**	**Important**	**100%**
		Very difficult to find	0%	Very important	0%

ASIC Digital designer

Occupational blueprint

An ASIC digital designer is a sub-profile of digital designer.

Number of stakeholder(s) involved in the design of the occupational blueprint: 1

	Entry / Junior Level	Mid-level	Senior level
Seniority of profiles recruited in the next 12 months	20%	30%	50%
Level of difficulty to find skilled candidates on a scale of 0 to 10 (10 is the maximum)	4/10	7/10	9/10
Average duration to fill a vacant position	>3 months	>6 months	>9 months
Average duration of the training of new hires till they become productive	8 to 12 months	4 to 9 months	1 to 2 months
Minimum educational level	EQF 6 with additional training on the job		EQF 4
Estimated percentage of the workforce requiring upskilling	20%		

Rank: From the most common to the less common field of study	Field of study of the workforce
1	- Information and computer engineering - Information technology
2	- Physics - Software engineering - Microelectronic engineering
3	- Mathematics - Electromechanical engineering
4	- Mechatronic - Biomedical engineering

5	- Advanced material science - Chemistry

Skills that are both the most needed and the most challenging to find

i. Level of difficulty to find the skill on a scale of 0 to 10 (10 is the maximum)
ii. Importance of the skill on a scale of 0 to 10 (10 is the maximum)
iii. Comments

The minimum educational level required for ASIC digital designers' candidates at the entry level is EQF 6. Therefore, the skills described below must be acquired once students reach the EQF level 6.

N°	Skill	Questions	Entry Level	Mid-Level	Senior level
1	Sensor ASIC development: ASIC partitioning, architecture and interaction	i	10	9	9
		ii	8	10	10
		iii	Defining architectures needs industry experiences		
2	Sensor ASIC development: ASIC verification	i	9	8	8
		ii	8	9	9
		iii	Design, Tooling and Method skills needed		
3	Sensor ASIC development: ASIC digital backend	i	8	8	9
		ii	8	8	10
		iii	Design, Tooling and Method skills needed		
4	Embedded Systems (FPGA, µc): µc specification, architecture and design	i	10	8	8
		ii	6	6	8
		iii	FPGA based systems are well taught in universities. Transfer to VHDL/ Verilog is not similar to FPGA design. Needed for many companies. Availability limited		
5	Sensor ASIC development: ASIC digital/mixed signal design	i	7	7	8
		ii	8	9	9
		iii	Design, Tooling and Method skills needed		
6	Sensor SW development: (algorithm development and digital) Signal processing CE sensors	i	7	8	8
		ii	7	7	7
		iii	-	-	-
7	Sensor ASIC development: ASIC mixed signal test engineering	i	5	6	7
		ii	6	8	8
		iii	Measurement principles are taught in universities, but not the needed tooling on testers. Good profiles in case of tooling experiences on testers		
8	Embedded Systems (FPGA, µc): Embedded system simulation, emulation and rapid prototyping	i	7	6	6
		ii	6	6	7
		iii	FPGA based systems are well taught in universities. However, transfer to VHDL/Verilog is not similar to FPGA design.		

			Needed for many companies. Availability limited		
9	Customer Systems and Applications: Product application regarding Use case (drones, indoor navigation, pico projection, etc.)	i	7	6	6
		ii	6	6	6
		iii	Personal motivation needed		
10	Methods and Processes: Illustration of technical data	i	5	5	6
		ii	5	5	5
		iii	Technical vocabulary needed. Application and reliability knowledge needed		
11	Methods and Processes: Product engineering & production methodology	i	8	6	5
		ii	5	5	5
		iii	Already easy to find in the workforce		

Foresight exercise: The three skills that will gain the most importance by 2025 for this profile

N°	Name of the skill	Description
Skill 1	ASIC digital partitioning, architecture and interaction	Ideally also with microcontroller partitioning
Skill 2	ASIC digital verification	New end effective methods like UVM and digital on top of verification for mixed signal top level simulations (including analog models)
Skill 3	ASIC digital design	Real VHDL, and Verilog designs. Not FPGA design

Robotic engineer

The main skills and knowledge associated are (see the dedicated chapter in the main skills):

- Software skills.
- Data analysis.
- Security.

Occupational blueprint

Representativeness of stakeholders involved in the design of the occupational blueprint	
Number of stakeholder(s)	• 10 companies • 3 universities • 1 other organisation • 1 focus group
Number of robotic engineers employed by companies	> 1000
Number of students in robotic engineering trained by Universities	> 1200 students

Educational level of hires

	Certificate / diploma (EQF 4-5)	Bachelor degree / BSc (EQF 6)	Master degree (EQF 7)	PhD (EQF 8)
Educational level of hires	0%	51%	47%	2%

	Entry / Junior Level	Mid-level	Senior level
Seniority of profiles recruited in the next 12 months	90%	5%	5%
Level of difficulty to find skilled candidates on a scale of 0 to 10 (10 is the maximum)	Unknown		
Average duration to fill a vacant position			
Average duration of the training of new hires till they become productive	6 months	Unknown	
Minimum educational level	EQF 6-7		

Rank: From the most common to the less common field of study	Field of study of the workforce
1	- Electromechanical engineering - Mechatronic
2	- Software engineering - Biomedical engineering
3	- Information and computer engineering - Information technology
4	- Microelectronic engineering - Physics - Mathematics
5	- Advanced material science - Chemistry

Skills that are both the most needed and the most challenging to find at the entry level.

The minimum educational level required for robotic engineers' candidates at the entry level is EQF 6-7. Therefore, the skills described below must be acquired once students reach the EQF level 6-7.

N°	Skill	Difficulty to find the skill (in percentage of answers)		Importance of the skill (in percentage of answers)	
Mandatory knowledge / skill					
1	Data analysis skills and associated tools	Not needed	0%	Not needed	0%
		Easy to find	0%	Fairly important	0%

		Difficult to find	0%	Important	0%
		Very difficult to find	**100%**	**Very important**	**100%**
2	Software skills: Strong computer science fundamentals, programming, databases, machine learning, digital twins.	Not needed	0%	Not needed	0%
		Easy to find	27%	Fairly important	18%
		Difficult to find	27%	Important	18%
		Very difficult to find	**45%**	**Very important**	**64%**
3	Software skills: Program and code automated and/or embedded systems, e.g., C, C++, C#, Python, Arduino, Raspberry, PLC Ladder Logic, MS.NET, and Object-Oriented Programming.	Not needed	0%	Not needed	0%
		Easy to find	36%	Fairly important	27%
		Difficult to find	18%	Important	18%
		Very difficult to find	**45%**	**Very important**	**55%**
4	Software skills: Program and code, analyse and troubleshoot HMI's – human-machine interfaces.	Not needed	0%	Not needed	0%
		Easy to find	33%	Fairly important	33%
		Difficult to find	22%	Important	22%
		Very difficult to find	**44%**	**Very important**	**44%**
5	Security / Safety: Familiar with industrial safety systems and safety-critical software tools.	Not needed	10%	Not needed	10%
		Easy to find	20%	Fairly important	20%
		Difficult to find	20%	Important	20%
		Very difficult to find	**50%**	**Very important**	**50%**
6	Contribute in troubleshoot and repair of machinery with which the control systems interface.	Not needed	0%	Not needed	0%
		Easy to find	38%	Fairly important	38%
		Difficult to find	13%	Important	13%
		Very difficult to find	**50%**	**Very important**	**50%**
7	Assist and instruct in the operation of robotic equipment and diagnosis of control problems.	Not needed	0%	Not needed	0%
		Easy to find	38%	Fairly important	50%
		Difficult to find	13%	Important	0%
		Very difficult to find	**50%**	**Very important**	**50%**
8		Not needed	0%	Not needed	0%

	Train, teach, and coach team members utilizing Lean processes.	Easy to find	38%	Fairly important	50%
		Difficult to find	**38%**	Important	0%
		Very difficult to find	25%	**Very important**	**50%**
9	Collaboration with other engineering departments (e.g., design engineers, system engineers).	Not needed	0%	Not needed	0%
		Easy to find	25%	Fairly important	38%
		Difficult to find	**63%**	Important	13%
		Very difficult to find	13%	**Very important**	**50%**
10	Analyse causes and implement corrective action on repetitive or major manufacturing problems.	Not needed	0%	Not needed	0%
		Easy to find	**50%**	Fairly important	38%
		Difficult to find	13%	Important	13%
		Very difficult to find	38%	**Very important**	**50%**
11	Establish and update schedules for all maintenance of robotic equipment, manage calibration procedures.	Not needed	0%	Not needed	0%
		Easy to find	**57%**	Fairly important	43%
		Difficult to find	14%	**Important**	**14%**
		Very difficult to find	29%	Very important	43%
Optional knowledge / skills					
12	Excellent understanding in mechanical / electrical and robotic engineering, process control and developing step logic for hardware control systems.	Not needed	0%	Not needed	0%
		Easy to find	33%	**Fairly important**	**56%**
		Difficult to find	**56%**	Important	11%
		Very difficult to find	11%	Very important	33%
13	Proficient with motor Control utilizing variable frequency drives including regulation via PLC (programmable logic control) systems.	Not needed	0%	Not needed	0%
		Easy to find	38%	**Fairly important**	**56%**
		Difficult to find	**38%**	Important	11%
		Very difficult to find	25%	Very important	33%
14	Design, program and aid in the installation of robotic equipment and related systems.	Not needed	0%	Not needed	0%
		Easy to find	**63%**	**Fairly important**	**63%**
		Difficult to find	13%	Important	0%

		Very difficult to find	25%	Very important	38%
15	Specify instrumentation for manufacturing equipment and related systems.	Not needed	0%	Not needed	0%
		Easy to find	**29%**	**Fairly important**	**57%**
		Difficult to find	43%	Important	14%
		Very difficult to find	29%	Very important	29%
16	Technical presentation, report writing, intermediate skills in MSOffice and SAP.	Not needed	0%	Not needed	0%
		Easy to find	**50%**	**Fairly important**	**57%**
		Difficult to find	25%	Important	0%
		Very difficult to find	25%	Very important	43%

Foresight exercise: The skills that will gain the most importance by 2025 for this profile

N°	Name of the skill	Description
1	Software skills	Skills number 2, 3 and 4 in the above table.
2	Teamwork and collaboration for CAD design	-
3	Security - Safety	Skill number 5 in the above table. Prevention of industrial spying and possible failures originated from improper use of malicious codes. Familiar with industrial safety systems and safety-critical software tools.

Process technician

A manufacturing technician is in charge of operating production equipment according to process instructions, moving the material between process steps next to the step controlled by the operator.

The main skills and knowledge associated are (see the dedicated chapters in the main skills):

- Introduction to materials (traditional materials and emerging ones).
- Knowledge of basic production processes (especially semiconductors).

Occupational blueprint

Representativeness of stakeholders involved in the design of the occupational blueprint	
Number of stakeholder(s)	• 13 companies • 2 focus groups
Number of process technicians employed by companies	> 6 000

Educational level of hires

	Certificate / diploma (EQF 4-5)	Bachelor degree / BSc (EQF 6)	Master degree (EQF 7)	PhD (EQF 8)
Educational level of hires	60%	40%	0%	0%

	Entry / Junior Level	Mid-level	Senior level
Seniority of profiles recruited in the next 12 months	30%	25%	45%
Level of difficulty to find skilled candidates on a scale of 0 to 10 (10 is the maximum)	Easy to find (4/10)	Very difficult to find (9/10)	Very difficult to find (10/10)
Average duration to fill a vacant position	1-4 months	9-12 months	12-24 months
Average duration of the training of new hires till they become productive	12 months	7 months	3-4 months
Minimum educational level	EQF 4		

Rank: From the most common to the less common field of study	Field of study of the workforce
1	- Mechatronic
2	- Microelectronic engineering
3	- Electromechanical engineering - Information and computer engineering - Mechanical engineering - Physics - Chemistry
4	- Information technology - Advanced material science
5	- Mathematics - Software engineering - Biomedical engineering

Skills that are both the most needed and the most challenging to find at the entry level.

The minimum educational level required for process technicians' candidates at the entry level is EQF 4. Therefore, the skills described below must be acquired once students reach the EQF level 4.

N°	Skill	Difficulty to find the skill (in percentage of answers)		Importance of the skill (in percentage of answers)	
Mandatory knowledge / skill					
1		Not needed	0%	Not needed	80

	Introduction to materials (traditional materials and emerging ones).	Easy to find	0%	Fairly important	0%
		Difficult to find	0%	Important	0%
		Very difficult to find	**100%**	**Very important**	**100%**
2	Knowledge of production processes (especially semiconductors).	Not needed	0%	Not needed	0%
		Easy to find	0%	Fairly important	0%
		Difficult to find	0%	Important	0%
		Very difficult to find	**100%**	**Very important**	**100%**
3	Act on failures of machines, assist in repair and documentation.	Not needed	0%	Not needed	8%
		Easy to find	15%	Fairly important	31%
		Difficult to find	38%	Important	15%
		Very difficult to find	**46%**	**Very important**	**46%**
4	Learn and install new manufacturing lines, support pilot manufacturing.	Not needed	8%	Not needed	17%
		Easy to find	8%	Fairly important	33%
		Difficult to find	25%	Important	0%
		Very difficult to find	**58%**	**Very important**	**50%**
5	Assist in root cause analyses of manufacturing defects and failures.	Not needed	8%	Not needed	8%
		Easy to find	17%	Fairly important	33%
		Difficult to find	17%	Important	8%
		Very difficult to find	**58%**	**Very important**	**50%**
6	Carry out preventive maintenance of manufacturing equipment.	Not needed	27%	Not needed	9%
		Easy to find	18%	Fairly important	18%
		Difficult to find	**18%**	Important	9%
		Very difficult to find	36%	**Very important**	**64%**
7	Support TPM procedures – total productive maintenance,	Not needed	11%	Not needed	22%
		Easy to find	22%	Fairly important	11%
		Difficult to find	**22%**	Important	11%

	cooperate with maintenance technician.	Very difficult to find	44%	**Very important**	**56%**
8	Keep and enforce health and safety regulations of manufacturing environment.	Not needed	0%	Not needed	0%
		Easy to find	**58%**	Fairly important	50%
		Difficult to find	8%	Important	0%
		Very difficult to find	33%	**Very important**	**50%**
9	Know the manufacturing process in an appropriate level.	Not needed	8%	Not needed	8%
		Easy to find	17%	Fairly important	31%
		Difficult to find	**25%**	**Important**	**15%**
		Very difficult to find	50%	Very important	46%
10	Execute product changeover and manufacturing start-up.	Not needed	15%	Not needed	15%
		Easy to find	15%	Fairly important	31%
		Difficult to find	**23%**	**Important**	**15%**
		Very difficult to find	46%	Very important	38%
11	Map, analyse and develop manufacturing processes.	Not needed	23%	Not needed	31%
		Easy to find	31%	Fairly important	15%
		Difficult to find	**8%**	**Important**	**15%**
		Very difficult to find	38%	Very important	38%
12	Monitoring the output of manufacturing line.	Not needed	25%	Not needed	23%
		Easy to find	25%	Fairly important	23%
		Difficult to find	**8%**	**Important**	**15%**
		Very difficult to find	42%	Very important	38%
13	Gather data from manufacturing and report it to senior staff members; basic knowledge in Word, Excel, Outlook, SAP, QDAS.	Not needed	8%	Not needed	15%
		Easy to find	31%	Fairly important	31%
		Difficult to find	**31%**	**Important**	**15%**
		Very difficult to find	31%	Very important	38%
14	Prepare, read, document engineering	Not needed	8%	Not needed	15%
		Easy to find	38%	Fairly important	31%

	drawings and drafting.	**Difficult to find**	**23%**	**Important**	**15%**
		Very difficult to find	31%	Very important	38%
15	Cooperate with process- and manufacturing engineers.	Not needed	0%	Not needed	0%
		Easy to find	42%	Fairly important	25%
		Difficult to find	**42%**	**Important**	**33%**
		Very difficult to find	17%	Very important	42%
16	Operates manufacturing equipment and machines.	Not needed	8%	Not needed	8%
		Easy to find	**62%**	Fairly important	38%
		Difficult to find	15%	**Important**	**15%**
		Very difficult to find	15%	Very important	38%
17	Lean manufacturing principles, keep workplace in proper order, 5S.	Not needed	0%	Not needed	0%
		Easy to find	**54%**	Fairly important	38%
		Difficult to find	15%	**Important**	**15%**
		Very difficult to find	31%	Very important	46%
18	Work instruction / documentation: Able to understand and perform task following the work instruction; Able to understand and use technical documentation; Able to run simple experiments according to pre-established plans.	Not needed	-	Not needed	0%
		Easy to find	-	Fairly important	0%
		Difficult to find	-	Important	0%
		Very difficult to find	-	Very important	0%
19	Communication: Able to communicate work in progress to next shift; Able to write reports.	Not needed	-	Not needed	0%
		Easy to find	-	Fairly important	0%
		Difficult to find	-	Important	0%
		Very difficult to find	-	Very important	0%
20	Process skills: Limit the impact of process hazards on the workshop and	Not needed	-	Not needed	0%
		Easy to find	-	Fairly important	0%
		Difficult to find	-	Important	0%

	the work in progress.	Very difficult to find	-	Very important	0%
Optional knowledge / skills					
21	Advanced skills in electronics repair works, soldering, quality check.	Not needed	30%	Not needed	40%
		Easy to find	**30%**	**Fairly important**	**30%**
		Difficult to find	30%	Important	10%
		Very difficult to find	10%	Very important	20%

Test technician

A test technician is responsible for testing and measuring electrical performances of the device under test. Verify and validate a software or an application thanks to automated, manual, performance and tests.

Occupational blueprint

Representativeness of stakeholders involved in the design of the occupational blueprint	
Number of stakeholder(s)	• 6 companies • 3 focus groups
Number of test technicians employed by companies	> 50

Educational level of hires

	Certificate / diploma (EQF 4-5)	Bachelor degree / BSc (EQF 6)	Master degree (EQF 7)	PhD (EQF 8)
Educational level of hires	60%	40%	0%	0%

	Entry / Junior Level	Mid-level	Senior level
Level of difficulty to find skilled candidates on a scale of 0 to 10 (10 is the maximum)	Easy to find (5/10)	Difficult to find (8/10)	Very difficult to find (9/10)
Average duration to fill a vacant position	3 months	12-18 months	2 years
Average duration of the training of new hires till they become productive	2 years	6 months	1 year
Minimum educational level	EQF 4		

Rank: From the most common to the less common field of study	Field of study of the workforce
1	- Electromechanical engineering
2	- Physics

3	- Information and computer engineering - Chemistry - Advanced material science
4	- Information technology - Microelectronic engineering - Mathematics - Software engineering - Biomedical engineering
5	- Mechatronic

Skills that are both the most needed and the most challenging to find at the entry level.

The minimum educational level required for test technicians' candidates at the entry level is EQF 4. Therefore, the skills described below must be acquired once students reach the EQF level 4.

N°	Skill	Difficulty to find the skill (in percentage of answers)		Importance of the skill (in percentage of answers)	
Mandatory knowledge / skill					
1	Cell/block/chip layout & Verification: Is responsible for transferring hierarchical schematics into a hierarchical layout. (Cell/block level). Performs all basic checks to guarantee a correct implementation of the schematics and assures compliance with the used technology and document the results.	Not needed	0%	Not needed	0%
		Easy to find	0%	Fairly important	0%
		Difficult to find	0%	**Important**	**100%**
		Very difficult to find	**100%**	Very important	0%
2	Floor planning: Creates a floorplan of the cell/block level layout to fit the given layout constraints and the full chip floorplan. Reports risk and status to team, geometrical insight.	Not needed	0%	Not needed	0%
		Easy to find	0%	Fairly important	0%
		Difficult to find	0%	**Important**	**100%**
		Very difficult to find	**100%**	Very important	0%
3	Mastery of tools and technology: Implements cell/block level layout, following the design rules. Knowledge of process and design specifications for qualified process and technology, tool knowledge e.g., Cadence Virtuoso and Mentor Calibre.	Not needed	0%	Not needed	0%
		Easy to find	0%	Fairly important	0%
		Difficult to find	0%	**Important**	**100%**
		Very difficult to find	**100%**	Very important	0%

4	Affinity with hardware electronics.	Not needed	0%	Not needed	0%
		Easy to find	0%	Fairly important	0%
		Difficult to find	0%	**Important**	**100%**
		Very difficult to find	**100%**	Very important	0%
5	Knowledge in programmable power supplies, function generators, multimeters.	Not needed	25%	Not needed	25%
		Easy to find	25%	Fairly important	25%
		Difficult to find	0%	Important	0%
		Very difficult to find	**50%**	**Very important**	**50%**
6	Assistance in planning Q-tests (product validation) and performing the tests.	Not needed	20%	Not needed	20%
		Easy to find	0%	Fairly important	0%
		Difficult to find	20%	Important	20%
		Very difficult to find	**60%**	**Very important**	**60%**
7	Keep and enforce health and safety regulations at test area.	Not needed	17%	Not needed	17%
		Easy to find	0%	Fairly important	0%
		Difficult to find	33%	Important	17%
		Very difficult to find	**50%**	**Very important**	**67%**
8	Support and cooperate with test engineers, support product development.	Not needed	20%	Not needed	20%
		Easy to find	0%	Fairly important	20%
		Difficult to find	20%	Important	0%
		Very difficult to find	**60%**	**Very important**	**60%**
9	Communication: Able to communicate work in progress to next shift; Able to write reports.	Not needed	0%	Not needed	0%
		Easy to find	0%	Fairly important	0%
		Difficult to find	50%	Important	50%
		Very difficult to find	**50%**	**Very important**	**50%**
10	Setup and operate back-end test equipment and bench-test equipment.	Not needed	0%	Not needed	0%
		Easy to find	33%	Fairly important	14%
		Difficult to find	**50%**	Important	29%
		Very difficult to find	17%	**Very important**	**57%**

11	Conduct product quality tests, in-circuit-tests, functional tests, burn-in tests.	Not needed	0%	Not needed	0%
		Easy to find	20%	Fairly important	17%
		Difficult to find	**40%**	Important	17%
		Very difficult to find	40%	**Very important**	**67%**
12	Supervision of test equipment maintenance, prevent and repair test machines.	Not needed	17%	Not needed	17%
		Easy to find	33%	Fairly important	17%
		Difficult to find	**17%**	Important	0%
		Very difficult to find	33%	**Very important**	**67%**
13	Reveal recurring process-material-machine problems – assist in developing corrective actions.	Not needed	0%	Not needed	0%
		Easy to find	17%	Fairly important	17%
		Difficult to find	**50%**	Important	17%
		Very difficult to find	33%	**Very important**	**67%**
14	Update and maintain product reliability testing data.	Not needed	20%	Not needed	20%
		Easy to find	**40%**	Fairly important	20%
		Difficult to find	0%	Important	0%
		Very difficult to find	40%	**Very important**	**60%**
15	Health-check and calibrate test and inspection equipment.	Not needed	17%	Not needed	17%
		Easy to find	33%	Fairly important	17%
		Difficult to find	0%	**Important**	**33%**
		Very difficult to find	**50%**	Very important	33%
16	Documentation, basic knowledge in Word, Excel, Outlook, SAP, QDAS, compile product reports.	Not needed	0%	Not needed	0%
		Easy to find	33%	Fairly important	25%
		Difficult to find	17%	**Important**	**50%**
		Very difficult to find	**50%**	Very important	25%
17	Monitor and record the parameters and downtime of test stations.	Not needed	0%	Not needed	0%
		Easy to find	33%	Fairly important	14%
		Difficult to find	**33%**	**Important**	**43%**

		Very difficult to find	33%	Very important	43%
18	Conduct climatic tests and interpret validation test, perform passive tests.	Not needed	20%	Not needed	17%
		Easy to find	20%	Fairly important	0%
		Difficult to find	**40%**	**Important**	**50%**
		Very difficult to find	20%	Very important	33%
19	Monitor and inspect devices under test, recognize and act on failures.	Not needed	33%	Not needed	33%
		Easy to find	0%	Fairly important	0%
		Difficult to find	**50%**	**Important**	**33%**
		Very difficult to find	17%	Very important	33%
20	Assist in install of new test stations, gather and measure relevant data.	Not needed	17%	Not needed	17%
		Easy to find	0%	Fairly important	17%
		Difficult to find	**67%**	**Important**	**33%**
		Very difficult to find	17%	Very important	33%
21	Prepare, read, interpret engineering drawings and drafting.	Not needed	0%	Not needed	0%
		Easy to find	20%	Fairly important	0%
		Difficult to find	**40%**	**Important**	**67%**
		Very difficult to find	40%	Very important	33%

Manager or Director

Occupational blueprint

Representativeness of stakeholders involved in the design of the occupational blueprint	
Number of stakeholder(s)	12 companies
Number of managers or directors employed by companies	Around 220

Educational level of hires

	Certificate / diploma (EQF 4-5)	Bachelor degree / BSc (EQF 6)	Master degree (EQF 7)	PhD (EQF 8)
Educational level of hires	0%	0%	85%	15%

	Entry / Junior Level	Mid-level	Senior level

Level of difficulty to find skilled candidates on a scale of 0 to 10 (10 is the maximum)	Difficult to find (8/10)	Very difficult to find (10/10)	Very difficult to find (10/10)
Average duration to fill a vacant position	12 months	> 12 months	> 12 months
Average duration of the training of new hires till they become productive	8 months	< 8 months	
Minimum educational level	EQF 7		

Rank: From the most common to the less common field of study	Field of study of the workforce
1	- Information and computer engineering - Microelectronic engineering
2	- Physics - Chemistry
3	- Information technology - Advanced material science
4	- Electromechanical engineering - Mechatronic - Software engineering
5	- Mathematics - Biomedical engineering

Skills that are both the most needed and the most challenging to find at the entry level.
The minimum educational level required for managers' candidates at the entry level is EQF 7. Therefore, the skills described below must be acquired once students reach the EQF level 7.

N°	Skill	Difficulty to find the skill (in percentage of answers)		Importance of the skill (in percentage of answers)	
Mandatory knowledge / skill					
1	Set the vision, goals and objectives of the manufacturing and processing department.	Not needed	0%	Not needed	0%
		Easy to find	18%	Fairly important	0%
		Difficult to find	9%	Important	9%
		Very difficult to find	**73%**	**Very important**	**91%**
2		Not needed	8%	Not needed	8%

	Establish high technical standards through processes and culture.	Easy to find	17%	Fairly important	0%
		Difficult to find	0%	Important	8%
		Very difficult to find	**75%**	**Very important**	**83%**
3	Collaborate with engineering departments in the NPI process (transition of newly developed products into manufacturing).	Not needed	8%	Not needed	8%
		Easy to find	33%	Fairly important	0%
		Difficult to find	17%	Important	17%
		Very difficult to find	**42%**	**Very important**	**75%**
4	Manage business relationships with external partners, suppliers, customers, vendors.	Not needed	0%	Not needed	0%
		Easy to find	25%	Fairly important	17%
		Difficult to find	25%	Important	8%
		Very difficult to find	**50%**	**Very important**	**75%**
5	Identify and assign projects for continual improvement and expanded manufacturing capabilities.	Not needed	0%	Not needed	0%
		Easy to find	27%	Fairly important	18%
		Difficult to find	18%	Important	9%
		Very difficult to find	**55%**	**Very important**	**73%**
6	Identify and implement new production technologies.	Not needed	8%	Not needed	8%
		Easy to find	0%	Fairly important	17%
		Difficult to find	17%	Important	8%
		Very difficult to find	**75%**	**Very important**	**67%**
7	Support translation and transfer of product specifications from engineering to manufacturing requirements.	Not needed	0%	Not needed	0%
		Easy to find	17%	Fairly important	25%
		Difficult to find	25%	Important	17%
		Very difficult to find	**58%**	**Very important**	**58%**
8	Comply with the internal health & safety policies, inform management of unsafe working conditions.	Not needed	17%	Not needed	17%
		Easy to find	0%	Fairly important	25%
		Difficult to find	25%	Important	0%
		Very difficult to find	**58%**	**Very important**	**58%**
9		Not needed	10%	Not needed	10%

	Engage with R&D, data pipeline and product teams, facilitate the delivery of projects.	Easy to find	20%	Fairly important	40%
		Difficult to find	10%	Important	0%
		Very difficult to find	**60%**	**Very important**	**50%**
10	Deliver production processes, define manufacturing objectives.	Not needed	10%	Not needed	10%
		Easy to find	40%	Fairly important	10%
		Difficult to find	**10%**	Important	0%
		Very difficult to find	40%	**Very important**	**80%**
11	Assign, review and evaluate process and product engineering project work.	Not needed	0%	Not needed	0%
		Easy to find	27%	Fairly important	27%
		Difficult to find	**36%**	Important	9%
		Very difficult to find	36%	**Very important**	**64%**
12	Make decisions concerning selection, training, rating, discipline and remuneration of staff.	Not needed	17%	Not needed	9%
		Easy to find	25%	Fairly important	27%
		Difficult to find	**17%**	Important	9%
		Very difficult to find	42%	**Very important**	**55%**
13	Develop and manage staff through training, assignments and coaching.	Not needed	17%	Not needed	17%
		Easy to find	17%	Fairly important	17%
		Difficult to find	**25%**	Important	8%
		Very difficult to find	42%	**Very important**	**58%**
14	Develop and implement process development procedures that are compliant to FDA, ISO, GMP, etc. regulations and standards.	Not needed	20%	Not needed	20%
		Easy to find	30%	Fairly important	20%
		Difficult to find	**20%**	Important	10%
		Very difficult to find	30%	**Very important**	**50%**
15	Assist procurement, design, material and QA departments in vendor audits, root cause	Not needed	10%	Not needed	10%
		Easy to find	40%	Fairly important	40%
		Difficult to find	**20%**	Important	0%

	investigations and technical support	Very difficult to find	30%	**Very important**	**50%**
16	Specify and source process- and test equipment for improved manufacturing capabilities.	Not needed	27%	Not needed	27%
		Easy to find	18%	Fairly important	27%
		Difficult to find	**27%**	**Important**	**9%**
		Very difficult to find	27%	Very important	36%

Lead or supervisor

Occupational blueprint

Representativeness of stakeholders involved in the design of the occupational blueprint	
Number of stakeholder(s)	• 6 companies • 2 focus group
Number of lead or supervisor employed by companies	> 10

Educational level of hires

	Certificate / diploma (EQF 4-5)	Bachelor degree / BSc (EQF 6)	Master degree (EQF 7)	PhD (EQF 8)
Educational level of hires	0%	0%	50%	50%

	Entry / Junior Level	Mid-level	Senior level
Seniority of profiles recruited in the next 12 months	15%	15%	70%
Level of difficulty to find skilled candidates on a scale of 0 to 10 (10 is the maximum)	Easy to find (1/10)	Difficult to find (6/10)	Very difficult to find (9/10)
Average duration to fill a vacant position	1-3 months	3-8 months	12-18 months
Average duration of the training of new hires till they become productive	> 24 months	> 12 months	6-12 months
Minimum educational level	EQF 7-8		

Rank: From the most common to the less common field of study	Field of study of the workforce
1	- Physics - Microelectronic engineering
2	- Electromechanical engineering - Chemistry

3	- Information and computer engineering - Advanced material science
4	- Information technology
5	- Mechatronic - Mathematics - Software engineering - Biomedical engineering

Skills that are both the most needed and the most challenging to find at the entry level.

The minimum educational level required for supervisors' candidates at the entry level is EQF 7-8. Therefore, the skills described below must be acquired once students reach the EQF level 7-8.

N°	Skill	Difficulty to find the skill (in percentage of answers)		Importance of the skill (in percentage of answers)	
Mandatory knowledge / skill					
1	Lead and develop a team of process engineers, process technologists/technicians, and metallurgists, provide engineering oversight on the team.	Not needed	0%	Not needed	0%
		Easy to find	0%	Fairly important	13%
		Difficult to find	50%	Important	38%
		Very difficult to find	**50%**	**Very important**	**50%**
2	Monitor the collection and reporting of process data, improve processes and resolve systematic issues, report on key process metrics and investigation into process KPI deviations.	Not needed	0%	Not needed	0%
		Easy to find	50%	Fairly important	17%
		Difficult to find	**50%**	Important	33%
		Very difficult to find	0%	**Very important**	**50%**
3	Analyse business needs and make practical recommendations for continuous process improvement.	Not needed	0%	Not needed	0%
		Easy to find	33%	Fairly important	17%
		Difficult to find	**33%**	Important	33%
		Very difficult to find	33%	**Very important**	**50%**
4	Build and foster networks and relationships with internal/external technical experts and operational staff.	Not needed	0%	Not needed	0%
		Easy to find	17%	Fairly important	0%
		Difficult to find	**50%**	Important	50%

		Very difficult to find	33%	**Very important**	**50%**
5	Leadership, process engineering methodologies and project management, maintain collaborative work environment.	Not needed	0%	Not needed	0%
		Easy to find	20%	Fairly important	20%
		Difficult to find	**40%**	Important	0%
		Very difficult to find	40%	**Very important**	**80%**
6	Work and communicate with stakeholders from multiple disciplines and product teams.	Not needed	0%	Not needed	0%
		Easy to find	17%	Fairly important	29%
		Difficult to find	**67%**	Important	14%
		Very difficult to find	17%	**Very important**	**57%**
7	Support managers in the development of the annual execution plan, support managers in the development and management of the cost and capital expenditure budget.	Not needed	0%	Not needed	0%
		Easy to find	17%	Fairly important	14%
		Difficult to find	33%	**Important**	**43%**
		Very difficult to find	**50%**	Very important	43%
8	Develop operational plans, coordinate plant operation, support the production planning team.	Not needed	0%	Not needed	0%
		Easy to find	0%	Fairly important	29%
		Difficult to find	**67%**	**Important**	**43%**
		Very difficult to find	33%	Very important	29%
9	Perform ongoing process reviews to identify issues early on, define measurable success metrics, and drive alignment for production.	Not needed	0%	Not needed	0%
		Easy to find	0%	Fairly important	29%
		Difficult to find	**83%**	**Important**	**43%**
		Very difficult to find	17%	Very important	29%
10	Coordinate and provide project management to short term and long-term projects, facilitate process, production, operational improvements.	Not needed	0%	Not needed	0%
		Easy to find	33%	Fairly important	14%
		Difficult to find	**33%**	**Important**	**57%**
		Very difficult to find	33%	Very important	29%
11	Collaborate with management to identify, quantify, and develop	Not needed	0%	Not needed	0%
		Easy to find	33%	Fairly important	29%

	strategies for mitigating risks, improve risk management.	**Difficult to find**	**50%**	**Important**	**43%**
		Very difficult to find	17%	Very important	29%
12	Generate and execute equipment and manufacturing system's qualification (installation and operation qualification).	Not needed	0%	Not needed	0%
		Easy to find	33%	Fairly important	17%
		Difficult to find	**50%**	**Important**	**50%**
		Very difficult to find	17%	Very important	33%
13	Coordinate and conduct technical trainings to the process team on all level (engineer, technician, operator).	Not needed	0%	Not needed	0%
		Easy to find	17%	Fairly important	17%
		Difficult to find	**67%**	**Important**	**50%**
		Very difficult to find	17%	Very important	33%
14	Conduct performance coaching, provide individual feedback, handle all team performance and personnel issues.	Not needed	0%	Not needed	0%
		Easy to find	0%	Fairly important	33%
		Difficult to find	**83%**	**Important**	**50%**
		Very difficult to find	17%	Very important	17%
Optional knowledge / skills					
15	Promote SafeProduction work practices, support process safety management programs, facilitates safety improvements.	Not needed	0%	Not needed	0%
		Easy to find	33%	**Fairly important**	**67%**
		Difficult to find	**67%**	Important	17%
		Very difficult to find	0%	Very important	17%
16	Technical presentation, report writing, intermediate skills in MSOffice and SAP, use technical systems for reporting and analytics.	Not needed	0%	Not needed	0%
		Easy to find	33%	**Fairly important**	**50%**
		Difficult to find	**67%**	Important	17%
		Very difficult to find	0%	Very important	33%

Applications engineer

An applications engineer is in charge of process transfer from lab to customer site.

Occupational blueprint

Representativeness of stakeholders involved in the design of the occupational blueprint	
Number of stakeholder(s)	• 6 companies • 1 RTO

	• 3 focus groups
Number of applications engineers employed by companies	> > 40 application engineers

Educational level of hires

	Certificate / diploma (EQF 4-5)	Bachelor degree / BSc (EQF 6)	Master degree (EQF 7)	PhD (EQF 8)
Educational level of hires	0%	33%	33%	33%

	Entry / Junior Level	Mid-level	Senior level
Level of difficulty to find skilled candidates on a scale of 0 to 10 (10 is the maximum)	Easy to find (5/10)	Difficult to find (7/10)	Difficult to find (8/10)
Average duration to fill a vacant position	2-3 months	4-5 months	6-7 months
Average duration of the training of new hires till they become productive	6-12 months	3-8 months	1-6 months
Minimum educational level	EQF 6		
Estimated percentage of the workforce requiring upskilling	33-50%		

Rank: From the most common to the less common field of study	Field of study of the workforce
1	- Information technology - Information and computer engineering
2	- Physics - Chemistry - Mechanical / Electromechanical engineering - Process Design - Advanced material science
3	- Biomedical engineering - Medicine
4	- Microelectronic engineering - Mechatronic - Mathematics (in particular statistics) - Software engineering

Skills that are both the most needed and the most challenging to find at the entry level.

The minimum educational level required for applications engineers' candidates at the entry level is EQF 6. Therefore, the skills described below must be acquired once students reach the EQF level 6.

N°	Skill	Difficulty to find the skill (in percentage of answers)		Importance of the skill (in percentage of answers)	
Mandatory knowledge / skill					
1	Good communication skills and patience when being in contact with customers, Interdisciplinarity and cross-discipline communication.	Not needed		Not needed	
		Easy to find		Fairly important	
		Difficult to find	**100%**	Important	
		Very difficult to find		**Very important**	**100%**
2	Technical specification: It is hard to find someone with deep understanding and accuracy.	Not needed		Not needed	
		Easy to find		Fairly important	
		Difficult to find	**100%**	**Important**	**100%**
		Very difficult to find		Very important	
3	Understanding of market situation of on customer side (e.g.: medicine vs. power electronics have different aspects). Intuition in different technical aspects, broad general technical understanding (e.g.: Design, Layout, Application).	Not needed		Not needed	
		Easy to find		Fairly important	
		Difficult to find	**100%**	**Important**	**100%**
		Very difficult to find		Very important	
4	Testing products, hands on, performing measurements, laboratory skills, Design of demo/application boards. Verification will always be needed but not at large scale, it might become even less important in future, as simulation becomes better.	Not needed		Not needed	
		Easy to find	100%	Fairly important	
		Difficult to find	**100%**	**Important**	**100%**
		Very difficult to find		Very important	
5	Hardware / Software integration. Knowledge on Software-Interfaces, Communication methods (SPI, etc.). Ability to determine which software implementation method is best. Software upgrades/diagnosis for	Not needed		Not needed	
		Easy to find		Fairly important	
		Difficult to find	**100%**	**Important**	**100%**
		Very difficult to find		Very important	

	tooling: identifying faulty coding and software patches and new release to tooling.				
6	Process transfer from lab to customer site.	Not needed		Not needed	
		Easy to find		Fairly important	
		Difficult to find	**100%**	**Important**	**100%**
		Very difficult to find		Very important	
7	Simulation, Hardware in the Loop Combination	Not needed		Not needed	
		Easy to find		Fairly important	
		Difficult to find	**100%**	**Important**	**100%**
		Very difficult to find		Very important	
8	Generalist knowledge in microelectronics, especially hardware	Not needed		Not needed	
		Easy to find		Fairly important	
		Difficult to find	100%	Important	100%
		Very difficult to find		Very important	
Optional knowledge / skills					
9	Market specific know-how, must adapt to specific market, Difference for example between medicine (constraints defined by medical personnel) vs. control automation (where application engineer) could handle all.	Not needed		Not needed	
		Easy to find		**Fairly important**	**100%**
		Difficult to find	**100%**	Important	
		Very difficult to find		Very important	
10	Visionary Sight: “What does the customers want in the next years?”.	Not needed		Not needed	
		Easy to find		**Fairly important**	**100%**
		Difficult to find	**100%**	Important	
		Very difficult to find		Very important	
11	Technical documentation, application notes, data sheet interpretation, high carefulness.	Not needed		Not needed	
		Easy to find	**100%**	Fairly important	
		Difficult to find		**Important**	**100%**
		Very difficult to find		Very important	
12		Not needed		Not needed	

	General understanding of what a company can provide. System partitioning on chip level, analog vs. digital (collaboration), external vs. internal components.	**Easy to find**	**100%**	Fairly important	
		Difficult to find		**Important**	**100%**
		Very difficult to find		Very important	
13	Technical support for marketing (e.g.: at fairs)	Not needed		Not needed	
		Easy to find	**100%**	Fairly important	
		Difficult to find		**Important**	**100%**
		Very difficult to find		Very important	

Other skills and knowledge indicated as important:

- Skills associated to advanced packaging (SiP, Fan-In, Fan-Out, WL CSP, Advanced IC substrates (Flip chip-based packages), Stacking technologies (2.5D & 3D), embedded die).

Foresight exercise: The 3 skills that will gain the most importance by 2025 for this profile

Name of the skill	Description
Software knowledge	Simulation, CAD
Chemistry	Knowledge in Chemistry, process design
Semiconductor experience	Experience within the SC industry

Operator / Inspector

Occupational blueprint

Representativeness of stakeholders involved in the design of the occupational blueprint	
Number of stakeholder(s)	• 1 company • 1 RTO • 1 focus group
Number of operators employed by companies	> 2

Minimum educational level of hires: 5-6

Skills that are both the most needed and the most challenging to find at the entry level.

N°	Skill	Difficulty to find the skill (in percentage of answers)		Importance of the skill (in percentage of answers)	
Mandatory knowledge / skill					
1	Adhere to all plant and corporate safety rules, procedures, and guidelines, reports all safety	Not needed	0%	Not needed	0%
		Easy to find	0%	Fairly important	0%

	concerns or issues to immediate supervisor.	Difficult to find	50%	**Important**	**100%**
		Very difficult to find	**50%**	Very important	0%
2	Cooperate with other operators, supervisors, manufacturing technicians and manufacturing engineers.	Not needed	0%	Not needed	0%
		Easy to find	0%	Fairly important	0%
		Difficult to find	50%	**Important**	**100%**
		Very difficult to find	**50%**	Very important	0%
3	Perform all necessary quality checks on manufactured products, identify component issues based on visual inspection or inspection with measuring tools.	Not needed	0%	Not needed	0%
		Easy to find	0%	Fairly important	0%
		Difficult to find	**100%**	**Important**	**100%**
		Very difficult to find	0%	Very important	0%
4	Utilize CAD/CAM software tools when needed for quality checks and for component inspection.	Not needed	0%	Not needed	0%
		Easy to find	50%	Fairly important	0%
		Difficult to find	**50%**	**Important**	**100%**
		Very difficult to find	0%	Very important	0%
5	Follow all procedures and standards as defined within the ISO guidelines.	Not needed	0%	Not needed	0%
		Easy to find	50%	Fairly important	0%
		Difficult to find	**50%**	**Important**	**100%**
		Very difficult to find	0%	Very important	0%
6	Maintain process documentation and related reports. (e.g., machine downtime tracking), fill out maintenance log.	Not needed	0%	Not needed	0%
		Easy to find	50%	Fairly important	0%
		Difficult to find	**50%**	**Important**	**100%**
		Very difficult to find	0%	Very important	0%
7	Maintain a clean work environment by complying with procedures, rules, and regulations defined by manufacturing technicians and engineers.	Not needed	0%	Not needed	0%
		Easy to find	50%	Fairly important	0%
		Difficult to find	**50%**	**Important**	**100%**
		Very difficult to find	0%	Very important	0%

8	Utilize MRP (manufacturing resource planning) systems to log in/out of jobs.	**Not needed**	**50%**	Not needed	0%
		Easy to find	0%	Fairly important	0%
		Difficult to find	**50%**	**Important**	**100%**
		Very difficult to find	0%	Very important	0%
9	Read and comprehend internal production SOPs (Standard Operating Procedures).	Not needed	0%	Not needed	0%
		Easy to find	**100%**	Fairly important	0%
		Difficult to find	0%	**Important**	**100%**
		Very difficult to find	0%	Very important	0%
10	Product testing.	Not needed	-	Not needed	0%
		Easy to find	-	Fairly important	0%
		Difficult to find	-	**Important**	**100%**
		Very difficult to find	-	Very important	0%
Optional knowledge / skills					
11	Accurately operate and read inspection/measuring devices.	Not needed	0%	Not needed	0%
		Easy to find	0%	**Fairly important**	**100%**
		Difficult to find	**100%**	Important	0%
		Very difficult to find	0%	Very important	0%
11	Basic knowledge of electronics, materials, electronics manufacturing procedures, related equipment and safety requirements.	Not needed	0%	Not needed	0%
		Easy to find	**100%**	**Fairly important**	**100%**
		Difficult to find	0%	Important	0%
		Very difficult to find	0%	Very important	0%
12	Train on and operate a variety of machines based on production demands, perform daily machine start-up and shutdown procedures, observe/monitor machines during production.	Not needed	0%	Not needed	0%
		Easy to find	**100%**	**Fairly important**	**100%**
		Difficult to find	0%	Important	0%
		Very difficult to find	0%	Very important	0%
13	Move and position material to manufacturing machines, follow load/unload instructions of components based on setup	Not needed	0%	Not needed	0%
		Easy to find	**100%**	**Fairly important**	**100%**
		Difficult to find	0%	Important	0%

	sheet/Setup Machinist instructions.	Very difficult to find	0%	Very important	0%
14	Work in material stock, forklift operation, packaging, labelling.	Not needed	0%	Not needed	0%
		Easy to find	**100%**	**Fairly important**	**100%**
		Difficult to find	0%	Important	0%
		Very difficult to find	0%	Very important	0%
15	Make minor repairs on manufacturing machines, adjust machine offsets to maintain in-tolerance products.	**Not needed**	**50%**	**Not needed**	**50%**
		Easy to find	**50%**	**Fairly important**	**50%**
		Difficult to find	0%	Important	0%
		Very difficult to find	0%	Very important	0%
Skill/knowledge not needed					
16	Rework, repair out-of-spec products manufactured during the shift.	**Not needed**	**100%**	**Not needed**	**100%**
		Easy to find	0%	Fairly important	0%
		Difficult to find	0%	Important	0%
		Very difficult to find	0%	Very important	0%

Marketing engineer

Occupational blueprint

A marketing engineer (EQF 7) is an interdisciplinary engineer combining skills and knowledge of an application engineer with marketing skills and knowledge (sales, communication, understanding of customers' needs, etc.).

In the area of Product Marketing, "digital Marketing" is getting more and more important. In this field of area, companies try to build up experts.

Material engineer

Occupational blueprint

Material engineers are process engineers expert with greater knowledge of semiconductors and electronics materials.

Material engineers are missing in the industry and material engineers will become more and more important, especially in line with the development of I4.0.

The knowledge required for materials engineers today is much broader than in the past and focuses also on steels, polymers, ceramics, etc. The field of semiconductor/electronics materials requires knowledge not just on traditional material engineering, but additionally on chemical and physical sciences (e.g., nanostructures).

In the coming years, more and more production will be automated. As a consequence, material engineers should acquire more and more automation and data analysis skills.

Educational level (EQF): 6-7.

- Opportunity to build curriculum from Material science and/or chemistry and polymer sciences (at EQF 4-5-6), with a specialization in electronics and microelectronics at EQF 6-7. Today, most curriculum are starting with electrical engineering before the specialization in electronics / microelectronics.

The main skills and knowledge associated are:

- Ability to inspect, analyse, test and characterize materials, both in micro- and nano range.
- Knowledge of applications: Knowledge in typical application of new materials (e.g., in I4.0, connectivity, sensing properties of new materials) and ability to choose specific materials for specific end-user applications.
- Knowledge of a diversity of materials (both traditional and new materials): Steels, polymers, ceramics, shape-memory materials, composites, materials for additive manufacturing, garbitol, Gallium Nitride (GaN), etc. Especially in line with the development of I4.0. According to a European leader in semiconductor manufacturing, approximately 50% of the knowledge in silicium can be used for new materials. Yet, there is a need for specialists of new materials.
- Knowledge in chemical and physical sciences (e.g., nanostructures). Basic knowledge in chemistry (missing in many curricula).
- Methodology of quality, e.g Quality 3.0 and 4.0 Systems is required for material engineers. It requires a deep understanding of measurements and a physical sense of statistics.
- Machine learning / Artificial Intelligence.
- Environmental awareness.

Data scientist

Occupational blueprint

The demand of the microelectronics industry for data analysts is rising at a very fast pace, and this profile is becoming essential for companies. According to the companies interviewed, finding a skilled data analyst is rather easy and there is a great offer on the current European job market. However, it is difficult to find data scientists with a knowledge linked to the microelectronics industry.

Data analysts are in charge of the exploitation of the data generated within the manufacturing process to improve them.

Educational level (EQF): 6-7

The main skills and knowledge associated are data analysis skills and knowledge:

- Data management: SQL, etc.
- Data visualization: Tableau, etc.

- Data integrity: Ability to ensure integrity of data, particularly when using large volume of data. Knowledge of the techniques to assess the quality of data.
- Data Security & Privacy by design: Ability to ensure security of data & data privacy. Including IP protection.
- Data analysis: Ability to interpret and make sense of large volume of data. Knowledge of potential biased conclusion led by biased data.
- Machine learning / Artificial intelligence.
- Algorithm optimization. This skill is increasingly sought after by industrials.
- Performance Data Analysis: Analyzing performance data

Representativeness of stakeholders involved in the design of the occupational blueprint	
Number of stakeholder(s)	• 8 companies • 2 universities • 1 other organisation • 1 focus group

	Entry / Junior Level	Mid-level	Senior level
Level of difficulty to find skilled candidates on a scale of 0 to 10 (10 is the maximum)	Difficult to find skilled profiles for microelectronics		
Average duration to fill a vacant position	6-12 months	> 6-12 months	
Minimum educational level	EQF 6		

Quality engineer

Occupational blueprint

Quality engineer is an emerging profile, more and more needed by the microelectronics industry. A quality engineer is a specialized process engineer in charge of establishing repeatable and reproducible manufacturing process flows.

It is key to the commercialization of prototype manufacturing. Universities train excellent researchers who have innovative ideas in R&D phase but transferring the prototype phase to manufacturing quality control becomes critical part. It takes long time to train fresh PhDs and other university graduates to learn quality control and industrial manufacturing practices. However, it is easier to find fresh graduates or persons with long experience in universities or research institutes than persons with industrial experience with quality control knowledge.

Meanwhile, functional safety and reliability are increasingly important within manufacturing processes. For instance, reliability and functional safety are two of the four main domains where increased skills is required for microelectronics engineers in line with the development of automotive electronics, with security and cost management (according to the focus group on automotive organized by METIS).

- Reliability: The strong impulse in the search for improving the reliability of components, systems and, in particular, designs even more than in innovation itself. This makes the system design more

and more difficult and also asks for advanced testing systems to assess the reliability of the components. This implies a greater importance of test technicians and engineers and their associated skills for microelectronics companies serving the automotive industry

- Functional Safety (Quality): Vehicle safety is an aspect linked to the improvement of reliability and led to the introduction of Functional Safety and the ISO 26262.

Educational level (EQF): 6-7

The main skills and knowledge associated are:

- Basic knowledge on quality engineering.
- Quality assessments (skill): Knowledge of the methodology of quality (Quality 3.0 and 4.0), and ability to use Quality tools (including quality tools associated to I4.0).
- Reliability analyses: Multidisciplinary knowledge in failure analyses, physics of failure.
- Robustness of microelectronics: Electromagnetic compatibility (EMC), electromagnetic interference (EMI), electrostatic discharge (ESD), aging, radiation hardness...
- Deep understanding of measurements and a physical sense of statistics.
- System architecture.
- Teamwork: with engineers from other fields: chemical, physical, mechanical etc.
- Analytical knowledge in reliability.
- Functional safety.

Radio Frequency (RF) engineer

Occupational blueprint

Microelectronics engineer (EQF 7) specialized in Radio Frequency products and applications. This profile is increasingly needed as connectivity issues are more and more important in line with I4.0, 5G and 6G.

Power electronics engineer

Occupational blueprint

Microelectronics engineer (EQF 7) specialized in power electronics products and applications: power electronics courses, packaging for power applications (IGBT, etc.), etc.

Hardware engineer

Occupational blueprint

Also named PCB design & test engineer (EQF 6), this profile has been identified as among the 5 most wanted job profiles today for within the semiconductor design business at the level of EQF 6.

Main skills and knowledge required for a PCB designer engineer

No	Skills / knowledge	Level of criticality (1 to 10)	Level of difficulty to fill. (1 to 10)
1	**Proficient in Analogue Electronics**	7	9
2	**Proficient in Digital Electronics**	7	7

3	**Proficient with analogue and digital electronic design**: RF design, power supply design. Knowledge in analytical tools such as ETAP, schematic, spice simulation. Have an understanding of hardware description languages, e.g., VHDL	6	6
4	**Familiar with design for manufacturing**: Design for assembly, design for test, design for inspection approaches, optimize complex and advanced designs for manufacturability	3	5
5	**Execute design, development and testing of hardware components**	3	4

Expert in cybersecurity

Occupational blueprint

Profile similar to software engineer (EQF 6-7), but with a focus on the security skills and knowledge:

- Security by design (Especially important for IoT and I4.0.): Know-how and applicability of secure protocols necessary.
- Skills used for cyber-physical (production) systems like diagram a network for security.
- Cybersecurity
    - Advanced intrusion detection and prevention.
    - Advanced skills in forensics.
- Reverse engineering for the prevention of industrial spying (especially for test engineers).
- Safety issues.

MEMS developer

Occupational blueprint

Number of stakeholder(s) involved in the design of the occupational blueprint: 1

The minimum educational level required for MEMS developers' candidates at the entry level is EQF 7. Therefore, the skills described below must be acquired once students reach the EQF level 7.

Skills that are both the most needed and the most challenging to find:

i. Level of difficulty to find the skill on a scale of 0 to 10 (10 is the maximum)

ii. Importance of the skill on a scale of 0 to 10 (10 is the maximum)

N°	Skill	Questions	Entry Level	Mid-Level	Senior level
1	Fundamental design principles behind a scalable application	I	4	6	9
		ii	10	10	10
2	Develop simulation code in Matlab	I	3	4	5
		ii	5	5	5
3	Familiar with application development and basic development procedures	I	3	5	7
		ii	5	5	5
4	Familiar with databases (e.g., SQL), big data technologies (e.g., Hadoop), machine learning techniques	I	4	6	8
		ii	7	7	7
5	Plan and execute design version releases	I	5	5	5
		ii	5	5	5

6	Understand design management tools such as SVN	I	5	5	5
		ii	5	5	5
7	Read and understand design and design specification	I	5	7	7
		ii	5	7	7
8	Design, development, layout and testing of design elements	I	5	7	9
		ii	5	7	9
9	Identify risks, in any phase of the life cycle, managing them through closure	I	3	5	7
		ii	3	5	7
10	Manage cost and time constraints, develop best practices, routines and innovative solutions to improve design	I	3	5	7
		ii	3	5	7
11	Technical presentation, report writing, intermediate skills in MSOffice and SAP	I	2	2	2
		ii	2	2	2
12	Provide project stakeholders with relevant information for taking decisions	I	3	6	9
		ii	4	5	6
13	Collaborate with technology, design-, manufacturing engineers, system engineers and product managers	I	5	7	9
		ii	5	7	7