Presentation of the METIS

Skills Strategy, Skills Anticipation and Monitoring

Microelectronics Pact for Skills

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I) The METIS Skills Strategy, developed in 2020

Context

Electronics is an essential component of virtually all aspects of our daily lives. With the emergence of Artificial Intelligence (AI), **we are entering an era of connected intelligence** that will make **new demands on microelectronics technology** due to its capabilities used to sensor, process, and store data for AI uptake. That is why advanced skills of designing and manufacturing microelectronics **components and systems are becoming of strategic importance to Europe**. The microelectronics sector in Europe is responsible for directly 200,000 and indirectly 1,000,000 high-skilled jobs and the demand for new skills is unceasing. Without an up-to-date microelectronics skills-base, Europe will not be able to take a leading position in the digital economy and face critical challenges.

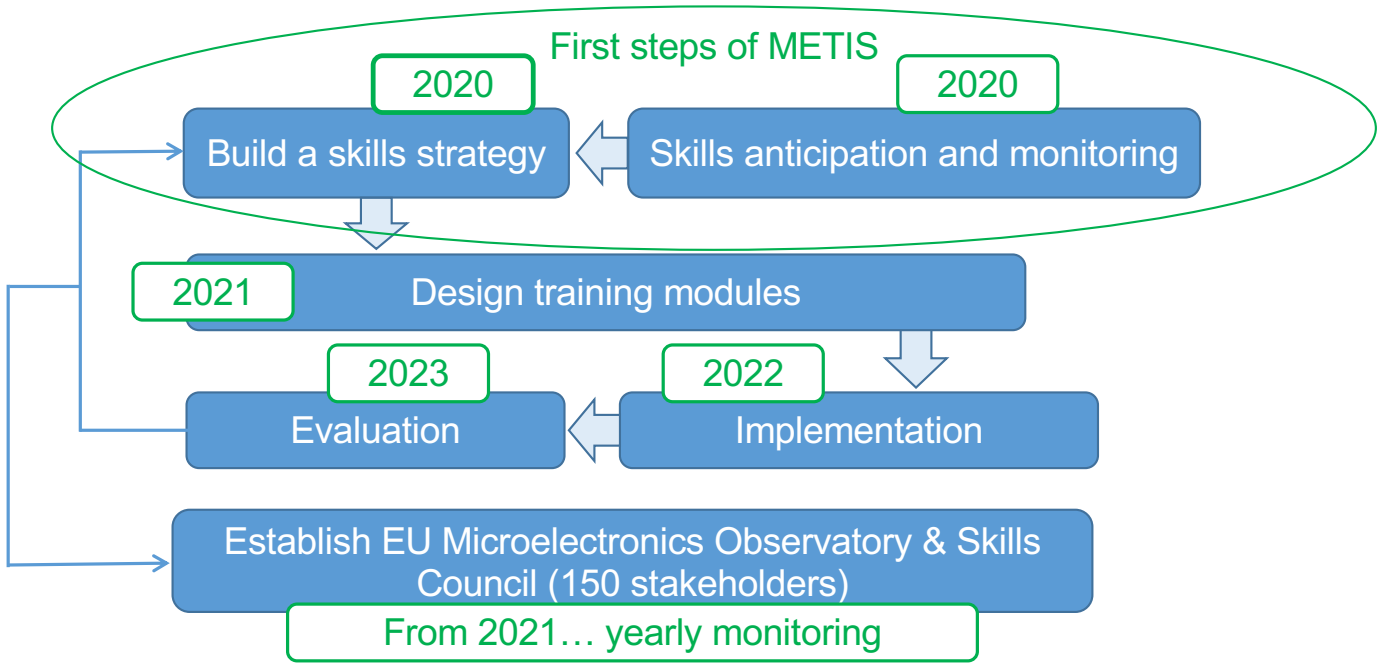
Co-funded by the Erasmus+ which the EU's programme to support education, training, youth and sport in Europe, METIS (MicroElectronics Training Industry and Skills) was launched in November 2019 as a Sector Skills Alliance on Microelectronics **to bridge the skills gap in microelectronics for a more competitive Europe** and **to pave the way for EU leadership in data driven technologies, enhancing high-skilled labor supply, addressing emerging skills needs and identifying jobs of the future** in the era of connected intelligence.

METIS will **highlight the key skills required in the microelectronics sector**, embedding **key expertise of Industry 4.0 technologies, artificial intelligence, cybersecurity and advanced chip** thanks to its **19 partners** representing industry (start-ups, SMEs, large firms), national and EU industry associations, formal educational providers and regulatory bodies in the field of accreditation and certification, and a market & intelligence company.

Brief overview of the implementation of the METIS project:

In 2020 and early 2021, DECISION was the Work Package leader in charge of the first step of the METIS project:

- Build a skills strategy to highlight current skill mismatches between the industry needs and the current educational provision as well as assess the future needs.



In 2020: EU sectoral skills strategy, skills anticipation and monitoring

- Multi-stakeholder's approach to skills identification

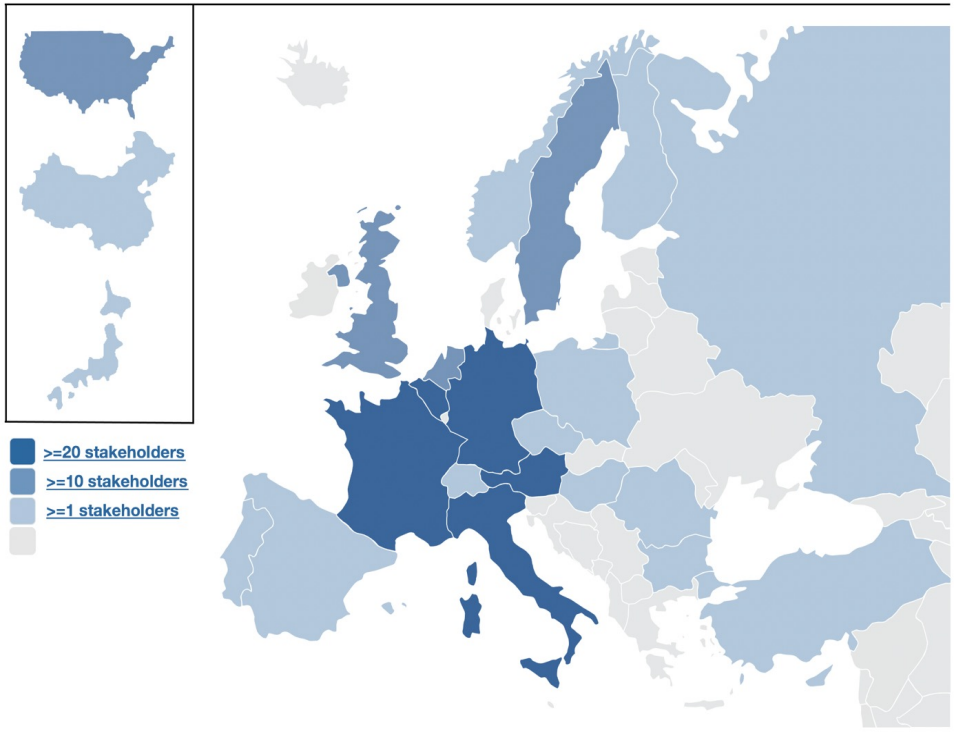
2 reports

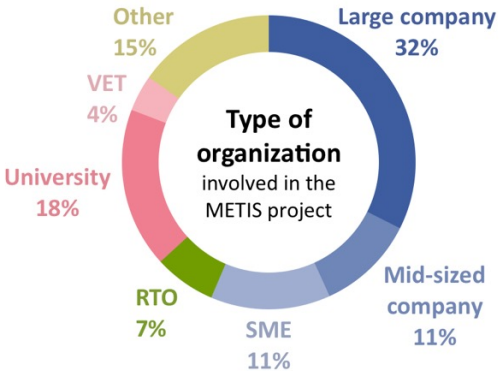
- Skills and Occupational Profiles for Microelectronics
- METIS Skills Strategy

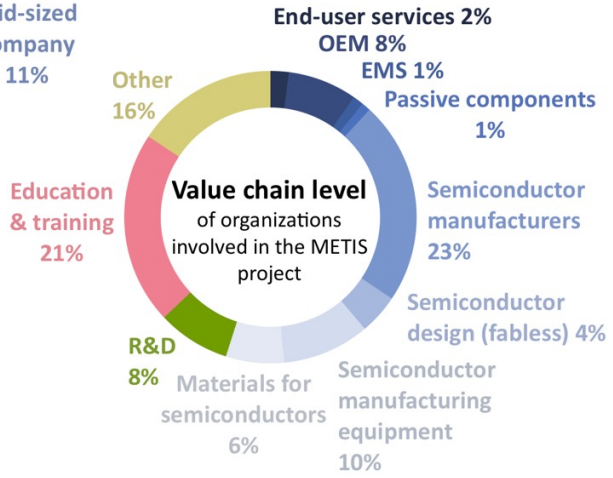
Organisations having participated in the METIS Skills Strategy, Skills Anticipation and Monitoring

- **251** stakeholders of **159** organisations engaged
- Representative for more than **125 000** microelectronics jobs across Europe
- **30%** of the European microelectronics workforce
- **24% of respondents were women** (More than the average of the sector in Europe)

Map - Nationality of stakeholders engaged in METIS







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II) Presentation of the results

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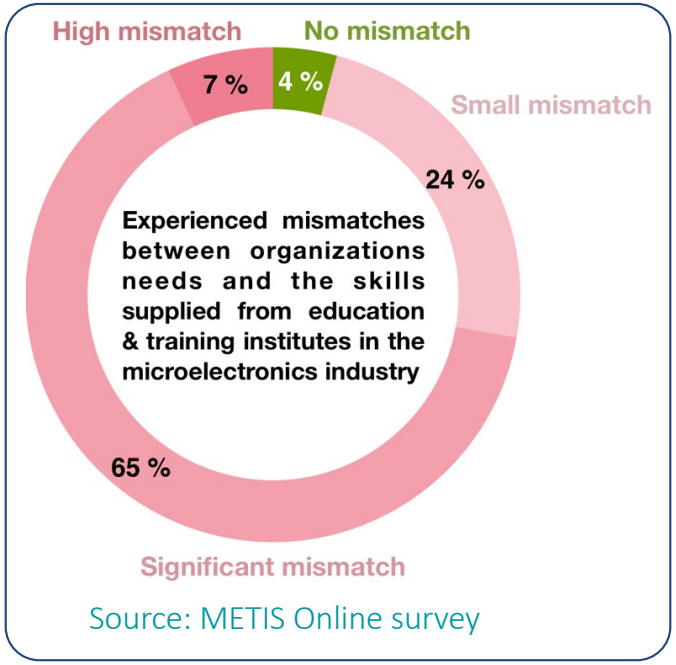
II) Presentation of the results

A) Skills anticipation and occupational profiles

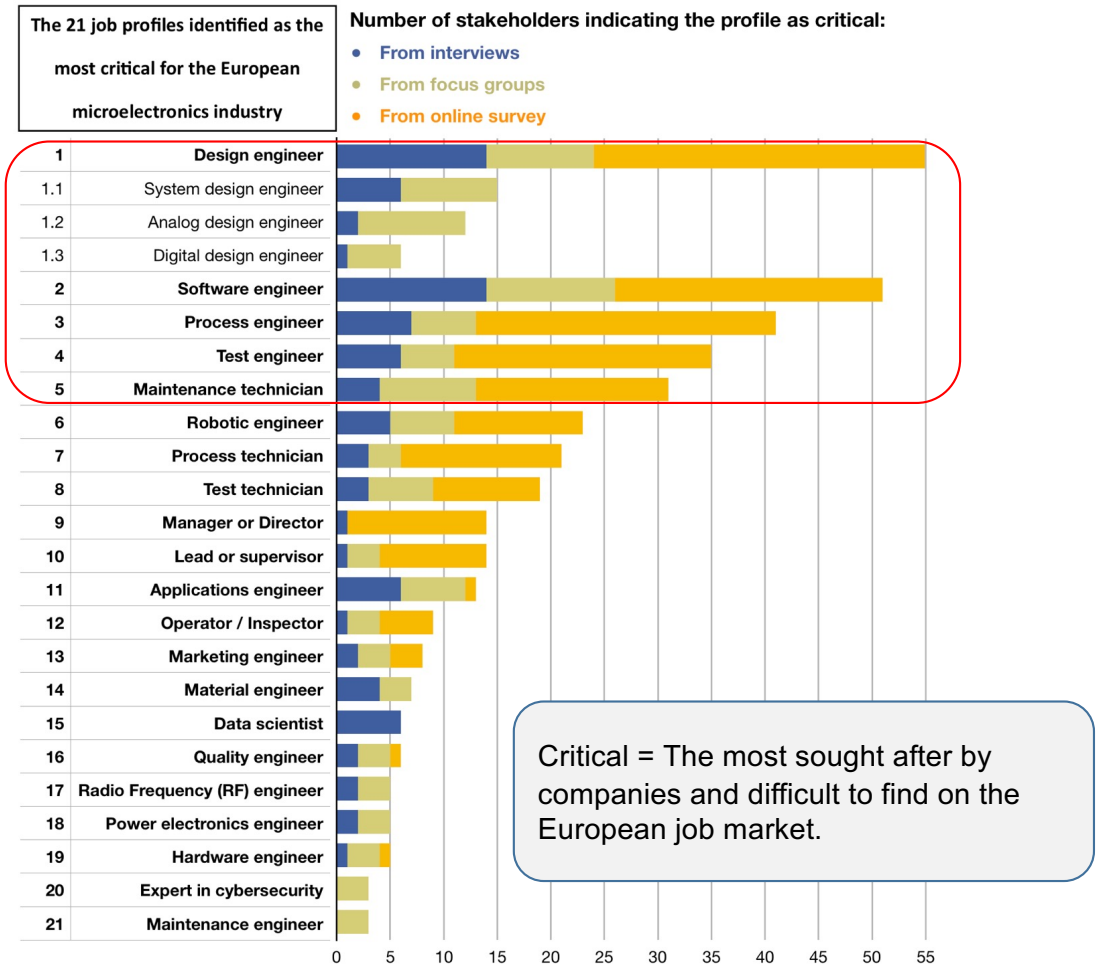
Main mismatches on the European microelectronics job market

1. **Needs for more fundamental knowledge in microelectronics**
    - Basics of electrical engineering, standard analog/digital circuit design, chemistry, physics, mathematics, mechanics, and introduction to materials.
    - As opposed to in-depth knowledge in very specific topics, often linked to state-of-the-art research.
2. **Needs for more basic skills linked to microelectronics manufacturing processes**
    - Design for production (reliability issues, etc.), standard tools for design and layout, standard process equipment, standard production processes, etc.
3. **Needs for more engineering profiles of generalists**
    - All engineers: common general knowledge of both microelectronics design and microelectronics manufacturing.
    - Focus on fundamental knowledge rather than emerging technologies.
    - Career long education programs…
4. **Needs for more multidisciplinary cursus** (especially microelectronics hardware + software and data analytics background)
5. **Needs for more curricula dedicated to microelectronics**



Source: METIS Online survey

Most critical job profiles on the European job market



N°	Job profile	Alternative names / Description	EQF at entry level
1	**Design engineer**	Designer	6-7
1.1	System design engineer	System designer, Product Architect, System Architect (HW/SW), System Development Engineer, HW/SW co-designer, System expert	7
1.2	Analog design engineer	Analog designer, Analog/Analog IC/Mixed-signal/ RF-IC Design Engineer	6-7
1.3	Digital design engineer	Digital designer	7
2	**Software engineer**	Controls and software engineer, Software developer, Solution engineer, Computer software engineer, Embedded/Firmware/Cloud software engineer, Software designer, Software design engineer	6-7
3	**Process engineer**	Manufacturing engineer	6-7
4	**Test engineer**	Component Verification & Validation Engineer / Lab-Verification & Validation Engineer / Field Service Engineer	6-7
5	**Maintenance technician**		5-6
6	**Robotic engineer**	Automation engineer	6-7
7	**Process technician**	Manufacturing technician	5-6
8	**Test technician**		5-6
9	**Manager or Director**		7-8
10	**Lead or supervisor**	Lab supervisor, shift leader	7-8
11	**Applications engineer**	Application engineering expert, Field applications engineer, Product development engineer, Product Manager, Requirement engineer, Industry 4.0 expert, Industrial power electronics expert, Supply chain manager with basic SC material knowledge	6-7
12	**Operator / Inspector**		5-6
13	**Marketing engineer**	Digital Marketing expert	7
14	**Material engineer**	Material experts, Specialist for new materials, Chemist	6-7
15	**Data scientist**	Dat analyst	6-7
16	**Quality engineer**	Quality expert, Requirement engineer, Reliability engineer. Understands both customers claims and technical fields. Coordinates quality assurance tasks, continuous improvement of processes, supplier quality (incoming material testing)	6-7
17	**RF engineer**		7
18	**Power electronics engineer**		7
19	**Hardware engineer**	PCB design & test engineer	6
20	**Expert in cybersecurity**	Similar to the security skills required for software engineer, but with a deeper knowledge level	7
21	**Maintenance engineer**		7

Most critical skills/knowledges on the European job market

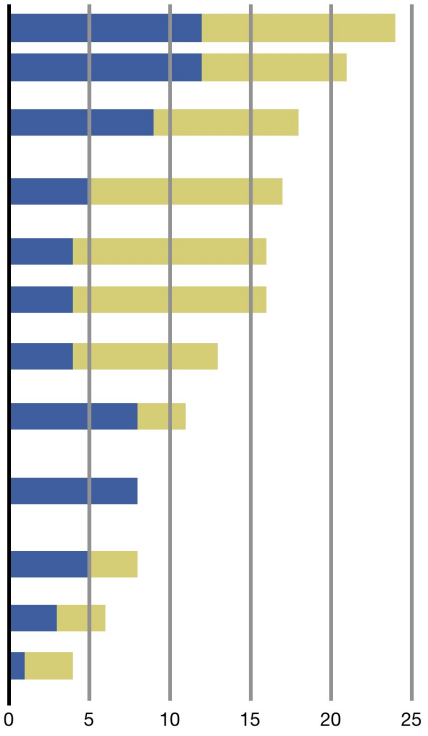
Great variability depending on job profiles.

Main trends summarized in the table below.

Knowledge associated to European strengths: Power, analog, RF => Connectivity, Power management innovations…

N°	Skill / Knowledge	Alternative names	Skill / knowledge required at Educational level (EQF)	The skill / knowledge is mandatory / optional	
				Mandatory	Optional
1	**Systems architectures**	System engineering	7	System design engineer	Design engineer
2	**Data analysis**	Big data	6-7	All profiles	-
3	**Artificial Intelligence / Machine learning**	Especially for software engineers, test engineers and design engineers	6-7	Software engineers / Data scientists	Other profiles. Important for Design engineers, Test engineers
4	**Knowledge of applications**		7	Application engineers / Material engineers / Design engineers / System design engineers / Software engineers	Other profiles
5	**Quality / reliability**		6-7	Process engineers	Other profiles
6	**Hardware / Software (HW/ SW) integration**	Hardware / Software co-design	6-7	Design engineers / System design engineers / Software engineers	Other profiles
7	**Security**	Security-by-design / Cybersecurity	6-7	Expert in cybersecurity / Software engineers / Robotic engineers / Process engineers / Test engineer	Other profiles
8	**Knowledge of new materials**	Knowledge of new materials and their applications	6-7	Process engineers / Material engineers	Other profiles
9	**Software skills**	Shift from hardware to software affecting most of the profiles	6-7	Software engineers / Data scientists / Robotic engineers / Process engineers / Materials engineers / Power electronics engineers / RF engineers	Other profiles
10	**Analog design**	Analog / Analog IC / Mixed-signal / RF-IC design	7	Design engineers and especially analog design engineers	-
11	**Environmental awareness**		4	-	All profiles
12	**Social inclusion and diversity**		4	-	All profiles

Number of stakeholders indicating the profile as critical:



Critical =

The most sought after by companies and difficult to find on the European job market.

Most critical soft skills on the European job market

- **Overall considered as almost as important as technical skills.**
- **Most critical soft skills required:**

1. **Teamwork & communication:** Increasingly complex topics, so teamwork and collaboration between teams become crucial. Ability to summarize complex topics for non-experts.
2. **Creativity:** Innovation capacity, ability to propose new ideas, new processes, new designs, to use new technologies, new applications.

METIS proposed 4 new ESCO* profiles linked to microelectronics

1. **Microelectronics designer** => Focus on developing and designing systems, from the top packaging level down to the integrated circuit level. System-level understanding with analogue and digital circuit knowledge, integrating the technology processes. Overall outlook in microelectronic sensor basics.

2. **Microelectronics smart manufacturing engineer** => Microelectronics smart manufacturing engineers design, plan and supervise the manufacturing and assembly of electronic devices and products, such as integrated circuits, automotive electronics or smartphones, in an Industry 4.0 compliant environment.

3. **Microelectronics materials engineer** => Design, develop and supervise the production of materials that are required for microelectronics and microelectromechanical systems (MEMS), and can apply them in these devices, appliances and products.

4. **Microelectronics maintenance technician** => In charge of preventive and corrective maintenance in semiconductor manufacturing.

METIS has also identified 13 other profiles that could lead to new ESCO profiles.

*ESCO (European Skills, Competences, Qualifications and Occupations) is the European multilingual classification of Skills, Competences and Occupations.

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II) Presentation of the results

B) Policy recommendations

Summary - Policy recommendations

1. **Increase the involvement of the microelectronics industry in the education process**
2. **Develop clusters and networks favoring dialog between industry and education representatives**
3. **Communication campaigns to improve the image of the sector**
4. **Sponsor state-of-the-art manufacturing infrastructures**
   - Shared facilities: large companies, education players, SMEs and research?
   - Adaptation to the EU digital compass?
5. **Develop joint degrees in microelectronics**
6. **Favor intra and extra-EU mobility**
7. **Others**

1) Involve the microelectronics industry in the education process

Actions:

1. Develop internships, apprenticeships, PhDs and graduate training programs co-organized (and co-funded?) by Universities and industrials.
2. Generalize the use of experts from the industry as teachers at the University.
3. Generalize the organisation of regular presentations of companies at Universities.
4. Develop life-long training programs:
    - Companies' involvement in the design of Universities and VET training programs.
    - Universities' courses hosted by companies' facilities.
    - Generalization of worked-based training.
    - Generalize co-funded and co-organized projects between Universities and companies.

2) Develop clusters and networks favoring dialog between industry and education representatives

Goals:

Facilitate the recruitment processes and benefit from synergies with education and research.

Actions:

Organisation of forums of discussions between the microelectronics industry and Universities & VET representatives to identify synergies and actions at the European level:

- Setting up dedicated groups defining and updating roadmap of skillset needed.
- Mapping training and course from European education provider.

Microelectronics pact for Skills

Observatory and Skills Council

3) Improve the image of microelectronics through communications campaigns

Goal: Rise the level of interest in microelectronics and attract talents.

Actions:

- Communication campaign to the public.
- Teach microelectronics-related topics at early stage of the education system (before EQF 4).
- Actions to raise the interest of students in STEM educations for technical jobs, electrical engineering and microelectronics.

Many stakeholders have another approach:

- Focus on strengthening the microelectronics industry and manufacturing on the European soil.
- A stronger industry will naturally attract more talents without the necessity of costly communication campaigns.

4) Sponsor state-of-the-art manufacturing infrastructures to be shared by large companies, education players, SMEs and R&D players

State-of-play

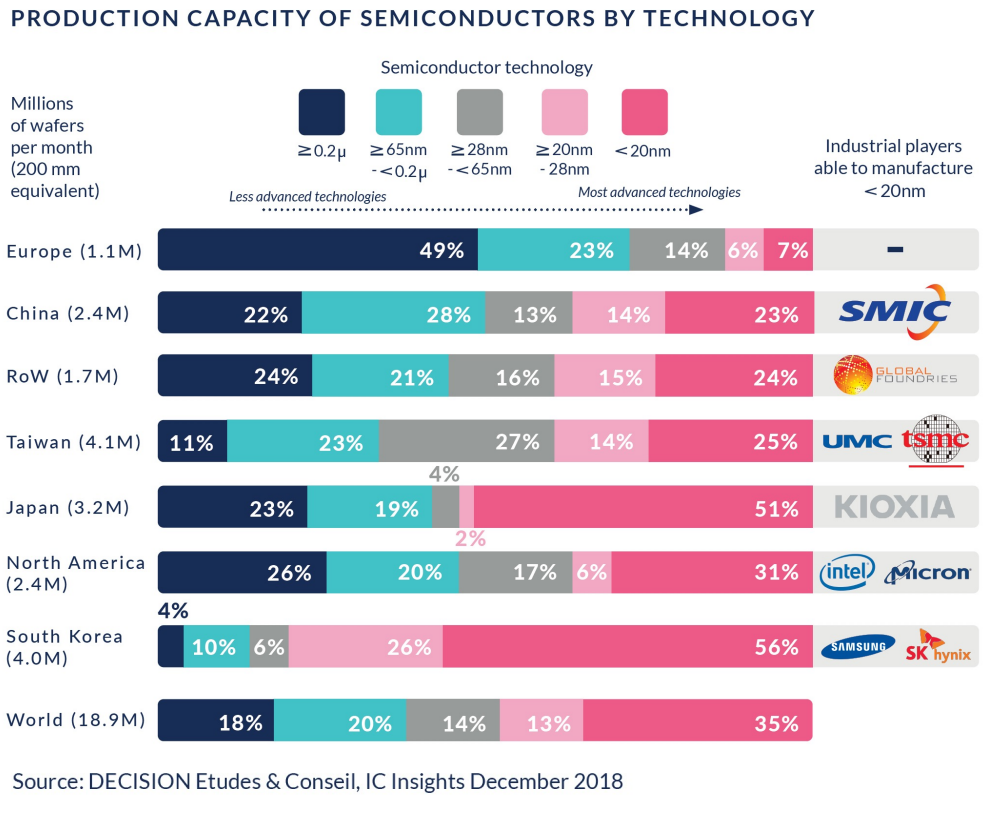
- Small European manufacturing base compared to other regions, and smaller in proportion years after years.
- Sovereignty & resiliency issue.
- Difficulty to maintain state-of-the-art R&D without applied R&D to state-of-the-art production processes. Special difficulty of access to manufacturing facilities for SME.

Illustration (opposite diagram)

- No European player able to manufacture below 20 nm.
- Only 7% of the production in Europe below 20 nm.

Actions

- Sponsor investments in state-of-the-art manufacturing capabilities in Europe, requiring highly concentrated investments.
- Ensure the access to such manufacturing capabilities for both large companies, SMEs and Universities to support R&D applied to state-of-the-art semiconductor manufacturing processes.



Source: DECISION Etudes & Conseil, IC Insights December 2018

4) Sponsor state-of-the-art manufacturing infrastructures to be shared by large companies, education players and SMEs

EU digital compass: Industrial goals by 2030

1. Europe to account for 20% of world production of processors in value (5-10% in 2020).
2. Manufacturing capabilities of processors below 5 nm.

Challenge for METIS and the Pact for Skills?

- Dedicate specific efforts towards manufacturing profiles?
  - Maintenance technicians
  - Process engineers
  - …
- Dedicate specific efforts to teach basic skills linked to microelectronics manufacturing processes as a common base for all students?

5) Develop Joint degrees in microelectronics

Proposals for joint degrees / curricula for microelectronics

Fields of study	Proposals for joint degrees			
	1	2	3	4
Microelectronics / Electro-engineering / Mechanics / Mechatronics	V	V	V	V
Software / Data science / Informatics	V			
Chemistry / Material science (Polymers, etc.)		V		
Marketing, Sales and Communication			V	
Biology / Natural Science				V

6) Favor intra and extra-EU mobility

Ease administrative processes

- To hire employees from abroad the EU.
- To facilitate intra-EU workers' mobility.

Enhance the uniformization of degrees and curriculum across the EU

- EQF/NQFs
- ESCO: Proposition of new profiles

7) Recommendations to involve all the players of the electronics value chain

- As shown by METIS project first results, **specific needs exist in upskilling and reskilling** the European workforce in microelectronics over the coming years.
- A necessity reinforced by the fact that the **pace of innovation of the sector advances faster than ever** not only **in microelectronics but also in all the other production levels of the electronics value** chain **from PCB, passive component, interconnection and electronic manufacturing services (EMS),** which are all deeply entertwined.
- So **taking into account the electronic supply chain as a whole appears essential** and all these players should have the opportunity to participate in the Microelectronics Pact for Skills on the same basis as players in the microelectronics value chain itself.
- Or as Erasmus+ provides funding dedicated to Sectoral Skills Alliances, designed to tackle skills in specific sectors, aligning Vocational Education and Training (VET) systems with labour market needs**: A Sectoral Skills Alliance could be proposed for other stages of the electronics value chain:** European PCB manufacturers, passive component suppliers, interconnection manufacturers and electronic manufacturing services (EMS).

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