

Address

FOR FUTURE



Appendix 7: Skill Map

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Objective: Determination of main roles and critical skills for AM

Key questions to be answered:

- What are the main roles in AM today and for the future?
- What are the key tasks of the determined roles?
- What is the required skill to perform respective tasks?
- What are benchmarks in industry doing?
- What are the capabilities and gaps in the industry?

Key Activities:

- Benchmarking with companies with high level AM standards
- Defining main roles and task description to perform the job.
- Determination of required critical skills for each role.
- Gathering inputs about skill matrix from stakeholders
- Determination of required skill level for each competency

Key Findings

- Knowledge and wide range of experience about **conventional manufacturing techniques** are essential for building up AM skills.
- **Commercial knowledge** is required to estimate cost to decide **the feasibility of AM technology**. Understanding of full cost of material post processing and testing is critical.
- **Knowledge about sustainability** is crucial to be able to identify business cases that can benefit from AM.
- **Hands on practical trainings** are essential to be able to identify best usage of AM.
- **Personal traits and behavioral competencies** are the **most differentiated** competencies especially for designer and process engineer.



Critical thinking: Objectively analysing the situation based on variety of information and knowledge on a subject. A kind of thinking which you question, analyse, interpret, evaluate and make a judgment.



Creative thinking: Ability to think about a task or problem in a new or different way. Ability to use imagination to generate new ideas. Thinking beyond the standards.



Eagerness to learning: Continues eagerness to learn more. Openness for new developments, continues research and follow up future trends, readiness for change. It is a proactive approach.



Initiative: Ability to think quickly and decide with confidence to take an action. Risk taking.



Teamwork: Active listening, respect others' opinions, experience, and knowledge, being brave to communicate agreement and disagreement, work in collaboration.

Unlike conventional manufacturing, the results of a recent study showed that there were not significant differences in job descriptions among AM employees. In fact, out of the 29 competencies that each position should possess, 17 of them were found to be similar across all AM positions.

Required Competency	
General Skills	AM Process Overview
	Conventional manufacturing technologies
	AM fundamentals
	Material Knowledge
	AM Manufacturing Technologies
	Computer aided design (CAD)
	Computer aided manufacturing (CAM)
	Computer aided engineering (CAE)
	AM international quality standarts
	Sustainability in AM
	Maintanance (TPM)
	Post process skills
	Safety knowledge
Process based skills	Design for related process (relevant principles)
	Design software (solidworks, fusion 360, catia...)
	Engineering analysis principles for related proces
	Analyses software
	Production of related process
	Quality testing and evaluation methods
Methodical & Behavioral Skills	Design thinking
	Process control and quality assurance methods
	Production economics and business economics
	Project management methods
	Critical thinking
	Curiosity
	Eagerness to learn
	Creative thinking (out of box thinking)
	Initiative (risk taking and decision making)
	Teamwork

This finding suggests that there is a high degree of overlap in the skills and knowledge required for different positions in AM, which could have significant implications for hiring practices, training programs, and workforce development strategies. By identifying the core competencies that are required for success in AM, companies can develop more effective training programs that focus on the specific skills and knowledge that are most critical to their operations.

Furthermore, the results of this study also highlight the importance of cross-training and developing a flexible workforce in AM. Since many of the competencies required for different positions overlap, employees can be trained in multiple areas, allowing them to take on a variety of roles within the organization. This can not only help to increase productivity and efficiency, but also provide employees with opportunities for growth and development within the company.

Overall, the findings of this study suggest that while there may be some differences in job descriptions among AM employees, there is also a significant degree of overlap in the skills and knowledge required for success in the industry. This highlights the need for companies to develop training programs that focus on the core competencies required for success in AM, as well as strategies for developing a flexible and cross-trained workforce.

In particular, one of the prominent issues is how behavioral skills come first in addition to technical knowledge in additive manufacturing competencies. Therefore, while giving technical education, it is necessary to give way to our training methods in the light of these determinations.

Conclusion for skill development



Before the industry

- Awareness and development activities in elementary or secondary schools to create a **generation with additive mind**
- Teaching methods to foster **creativity and adaptability skills**.
- «**Science and Art**» **trainings** in the university curricula to foster different way of thinking



In business life

- Training programs to provide **generalist and specialist courses**
- **Modular courses** to provide hand-on activities and industry practices
- Industry – academia **partnership**
- **Community based networking** to foster continues sharing and learning

SKILL MAP of AM ROLES:

	Required Competency	Designer				
		VAT	ME	MJ	PBF	DED
General Skills	AM process overview	x	x	x	x	x
	Conventional manufacturing technologies	x	x	x	x	x
	AM fundamentals	x	x	x	x	x
	Material knowledge	x	x	x	x	x
	AM manufacturing technologies	x	x	x	x	x
	Computer aided design (CAD)	x	x	x	x	x
	Computer aided manufacturing (CAM)					
	Computer aided engineering (CAE)	x	x	x	x	x
	AM international quality standards	x	x	x	x	x
	Sustainability in AM	x	x	x	x	x
	Maintenance (TPM)					
	Post process skills					
	Safety knowledge					
Process based skills	Design for related process (relevant principles)	x	x	x	x	x
	Design software (solid works, fusion 360...)	x	x	x	x	x
	Engineering analysis principles for related process	x	x	x	x	x
	Analyses software	x	x	x	x	x
	Production of related process	x	x	x	x	x
	Quality testing and evaluation methods					
Methodical & Behavioral Skills	Design thinking	x	x	x	x	x
	Process control and quality assurance methods					
	Production economics and business economics	x	x	x	x	x
	Project management methods	x	x	x	x	x
	Critical thinking	x	x	x	x	x
	Curiosity	x	x	x	x	x
	Eagerness to learn	x	x	x	x	x
	Creative thinking (out of box thinking)	x	x	x	x	x
	Initiative (risk taking and decision making)					
	Teamwork	x	x	x	x	x

- Prerequisite especially for designers: Imagination and curiosity. These are personal traits, difficult to develop. Therefore, need to be evaluated during hiring.

	Required Competency	Proces Engineer				
		VAT	ME	MJ	PBF	DED
General Skills	AM process overview	x	x	x	x	x
	Conventional manufacturing technologies	x	x	x	x	x
	AM fundamentals	x	x	x	x	x
	Material knowledge	x	x	x	x	x
	AM manufacturing technologies	x	x	x	x	x
	Computer aided design (CAD)	x	x	x	x	x
	Computer aided manufacturing (CAM)	x	x	x	x	x
	Computer aided engineering (CAE)	x	x	x	x	x
	AM international quality standarts	x	x	x	x	x
	Sustainability in AM	x	x	x	x	x
	Maintanance (TPM)	x	x	x	x	x
	Post process skills	x	x	x	x	x
	Safety knowledge	x	x	x	x	x
Process based skills	Design for related process (relevant principles)	x	x	x	x	x
	Design software (solid works, fusion 360...)	x	x	x	x	x
	Engineering analysis principles for related process	x	x	x	x	x
	Analyses software	x	x	x	x	x
	Production of related process	x	x	x	x	x
	Quality testing and evaluation methods	x	x	x	x	x
Methodical & Behavioral Skills	Design thinking	x	x	x	x	x
	Process control and quality assurance methods	x	x	x	x	x
	Production economics and business economics	x	x	x	x	x
	Project management methods	x	x	x	x	x
	Critical thinking	x	x	x	x	x
	Curiosity	x	x	x	x	x
	Eagerness to learn	x	x	x	x	x
	Creative thinking (out of box thinking)					
	Initiative (risk taking and decision making)	x	x	x	x	x
	Teamwork	x	x	x	x	x

	Required competency	Simulation Engineer				
		VAT	ME	MJ	PBF	DED
General Skills	AM process overview	x	x	x	x	x
	Conventional manufacturing technologies	x	x	x	x	x
	AM fundamentals	x	x	x	x	x
	Material Knowledge	x	x	x	x	x
	AM manufacturing technologies	x	x	x	x	x
	Computer aided design (CAD)	x	x	x	x	x
	Computer aided manufacturing (CAM)					
	Computer aided engineering (CAE)	x	x	x	x	x
	AM international quality standards	x	x	x	x	x
	Sustainability in AM					
	Maintenance (TPM)					
	Post process skills					
	Safety knowledge					
Process based skills	Design for related process (relevant principles)	x	x	x	x	x
	Design software (solid works, fusion 360...)	x	x	x	x	x
	Engineering analysis principles for related process	x	x	x	x	x
	Analyses software	x	x	x	x	x
	Production of related process	x	x	x	x	x
	Quality testing and evaluation methods					
Methodical & Behavioral Skills	Design thinking					
	Process control and quality assurance methods					
	Production economics and business economics					
	Project management methods					
	Critical thinking	x	x	x	x	x
	Curiosity	x	x	x	x	x
	Eagerness to learn	x	x	x	x	x
	Creative thinking (out of box thinking)					
	Initiative (risk taking and decision making)					
	Teamwork	x	x	x	x	x

	Required Competency	Operator		
		Machine	Post Process	Quality
General Skills	AM process overview	x	x	x
	Conventional manufacturing technologies	x	x	x
	AM fundamentals			
	Material knowledge			
	AM manufacturing technologies			
	Computer aided design (CAD)			
	Computer aided manufacturing (CAM)			
	Computer aided engineering (CAE)			
	AM international quality standards	x	x	x
	Sustainability in AM			
	Maintenance (TPM)	x	x	x
	Post process skills	x	x	x
	Safety knowledge	x	x	x
Process based skills	Design for related process (relevant principles)			
	Design software (solid works, fusion 360...)			
	Engineering analysis principles for related process			
	Analyses software			
	Production of related process			
	Quality testing and evaluation methods	x	x	x
Methodical & Behavioral Skills	Design thinking			
	Process control and quality assurance methods	x	x	x
	Production economics and business economics			
	Project management methods			
	Critical thinking			
	Curiosity			
	Eagerness to learn	x	x	x
	Creative thinking (out of box thinking)			
	Initiative (risk taking and decision making)			
	Teamwork			