



SAM Glossary

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Contents

Contents	2
1. Introduction.....	3
2. AM-specific terminology	3
3. Education terminology	13
4. SAM specific terminology and concepts	30

1. Introduction

It is important to have a consistent terminology within the project like SAM-ERASMUS. Specific to SAM, is the fact that two, typically separated areas of expertise: AM and education, are united. Therefore, a concise glossary is made as an easy reference for the project members not having a background in both areas.

2. AM-specific terminology

2.1. A historical introduction

The terminology used in Additive Manufacturing (AM) has gone through a turbulent evolution in the past 30 years. Just the term for Additive Manufacturing itself has evolved over the years:

- **Rapid Prototyping** (late 1980s to early 1990s): The first modern AM (Additive Manufacturing) technology was Stereo Lithography (patent 1986, first machine sold in 1987). The name Rapid came about since Stereo Lithography was mainly used to produce prototypes and it could do so much more rapidly than conventional manufacturing methods.
- **Rapid Tooling** (1990s to early 2000s): Again, the name comes from the application of the technology rather than what the technology actually does or how it works. AM was used to produce tools. Examples are the KEL tool, other indirect tooling technologies and early versions of DMLS.
- **Rapid Manufacturing** (late 1990s to mid-2000s): This is the ultimate example of naming a technology after the application. This term was used to denote the use of Rapid Prototyping techniques to produce end user parts.

After that, it became clear that there should be a naming convention for the technology itself (and the different processes realising it). Therefore, a clear distinction is made on how parts are manufactured (or more generally shaped). There are three categories of technologies to shape materials:

- **Subtractive shaping**: Shaping a material by successive subtracting pieces of material of the original block of material. e.g. machining, grinding, drilling, etc.
- **Formative shaping**: Shaping a raw material by the application of pressure to material: e.g. forging, pressing, bending, casting, etc.
- **Additive shaping**: Shaping by the successive addition of material(s): e.g. Additive Manufacturing technologies

So according to ISO¹ and ASTM² (ISO/ASTM 52900:2015):

***Additive Manufacturing (AM)**, noun, the process of joining materials to make parts from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing and formative manufacturing technologies.*

Many historical terms have circulated and are still being used today: additive fabrication, additive processes, additive techniques, additive layer manufacturing, layer manufacturing, solid freeform fabrication, freeform fabrication and many more.

It is important to note that AM does not imply a certain application of the parts being produced like the definitions of the older terms. The standard further specifies the names of 7 categories of Additive Manufacturing technologies:

- **Binder Jetting**: AM process in which a liquid bonding agent is selectively deposited to join powder materials.
- **Directed Energy Deposition**: AM process in which focused thermal energy is used to fuse materials by melting as they are being deposited.

Note 1 to entry: “Focused thermal energy” means that an energy source (for example: laser, electron beam, or plasma arc) is focused to melt the materials being deposited.

¹ ISO: International Organization for Standardization (www.iso.org).

² ASTM: American Society for Testing and Materials (www.astm.org).

- **Material Extrusion:** AM process in which material is selectively dispensed through a nozzle or orifice.
- **Material Jetting:** AM process in which droplets of feedstock material are selectively deposited. Note 1 to entry: Example feedstock materials for material jetting include photopolymer resin and wax.
- **Powder Bed Fusion:** AM process in which thermal energy selectively fuses regions of a powder bed.
- **Sheet lamination:** AM process in which sheets of material are bonded to form a part.
- **VAT Photopolymerisation:** AM process in which liquid photopolymer in a vat is selectively cured by light-activated polymerization.

All AM technologies can be classified into one of the categories above. These are the standard names to be used for the classifications. Below now is a list of AM technologies with their abbreviations, definitions and their classification:

2.2. AM-techniques

Acronym	Long name	Description	Category
SL	Stereolithography	Process used to produce objects from resins or liquid materials using one or more lasers to start locally the photopolymerisation, a process by which light causes chains of molecules to link, forming polymers.	VAT photopolymerisation
UVL-VAT Photopolymerization	Ultraviolet Laser beam-VAT Photopolymerization	Curing using an ultra violet laser beam exposure	VAT Photopolymerization
UVM - VAT Photopolymerization	Ultraviolet Mask - VAT Photopolymerization	Curing by exposure to ultraviolet selectively shining through a mask	VAT Photopolymerization
LED-VAT Photopolymerization	Light Emitting Diode - VAT Photopolymerization	Curing by exposure to lights from light emitting diodes	VAT Photopolymerization
SLA	Stereolithography Aparatus	Old name for stereolithography.	VAT photopolymerisation
	optical fabrication	Old name for stereolithography.	VAT photopolymerisation
	photo-solidification	Old name for stereolithography.	VAT photopolymerisation
CDLP	Continuous Direct Light Processing	Process that produces parts similar to DLP, but it relies on a continuous motion of build plate in Z direction (upwards)	VAT photopolymerisation

FDM	Fused Deposition Modelling	Process that uses a continuous filament of a thermoplastic material. Filament is fed from a large coil through a moving, heated printer extruder head, and is deposited on the growing work.	Material Extrusion
ME-TRB	Material extrusion – Thermal Reaction Bonding	Process that uses a continuous filament of material. Filament is fed from a large coil through a moving, heated printer extruder head, and is deposited on the growing work.	Material Extrusion
FFF	Fused filament fabrication, filament freeform fabrication	Fused Deposition Modelling.	Material Extrusion
FPF	Fused Particle Fabrication	Fused Deposition Modelling, from grains or pellets.	Material Extrusion
FGF	Fused Granular Fabrication	Fused Deposition Modelling, from grains or pellets.	Material Extrusion
ME-CRB	Material Extrusion – Chemical Reaction Bonding	Process that uses a continuous filament of material. Filament is fed from a large coil through a moving, the material is deposited on the growing work and is bonded by a chemical reaction.	Material Extrusion
LS	Laser Sintering	Process used to produce objects from powdered materials using one or more lasers to selectively fuse or melt the particles at the surface, layer upon layer, in an enclosed chamber.	Powder Bed Fusion
SLS	Selective Laser Sintering	Laser Sintering.	Powder Bed Fusion
LB-PBF	Laser Powder Bed Fusion	Process used to produce objects from powdered materials using one or more lasers to selectively fuse or melt the particles at the surface, layer upon layer, in an enclosed chamber, with several levels of power-density lasers.	Powder Bed Fusion
SLM	Selective Laser Melting	Additive manufacturing technique designed to use a high power-density laser to melt and fuse metallic powders together.	Powder Bed Fusion
DMLS	Direct metal laser sintering	See Selective laser melting,	Powder Bed Fusion
IrL-PBF	Infrared light Powder Bed Fusion	When the thermal energy source is infrared light	Powder Bed Fusion
DLP	Digital light Processing	Strictly speaking DLP, is the technology to control a cone-beam of light using a mirror-matrix on a semiconductor chip, the technology used in modern beamers. In AM, it refers to the manufacturing technology that	VAT photopolymerisation

		uses this optical technology to activate by light the photopolymerisation of a complete layer of resin, as in SL.	
EBM	Electron Beam Melting	Process where metal powders are consolidated into a solid mass using an electron beam as the heat source.	Powder Bed Fusion
BJ-SSt	Binder Jetting – Single Step process	The parts are joined directly with the bonding of the intended part material in a single process step.	Binder Jetting
MJF	Multi Jet Fusion	The Multi Jet Fusion process starts with a layer of material applied to the work area. In the opposite direction, in one continuous pass, the machine prints fusing and detailing agents across the full working area. This pass combines the printing with the fusing energy, and the process is completed. The innovative technology prints quickly along the bed width, enabling extreme precision and dimensional accuracy.	Binder Jetting
BJ-MSt	Binder Jetting – Multi-Step process	The parts need further process steps for consolidation and formation of the bonds of the intended part material.	Binder Jetting
MJ-UV	Material Jetting – Ultraviolet light	The jetted material needs curing by ultraviolet light exposure.	Material Jetting
MJ-CRB	Material Jetting – Chemical Reaction Bonding	The jetted material is bonded by a chemical reaction.	Material Jetting
MJ-TRB	Material Jetting – Thermal Reaction Bonding	The jetted material is bonded by a thermal reaction.	
	Polyjet	PolyJet 3D Printers jet layers of curable liquid photopolymer onto a build tray creating exceptional detail, surface smoothness and precision.	Material Jetting

NPJ	Nano particle jetting	Process where a liquid containing metal nanoparticles are jetted onto the build tray in extremely thin layer of droplets	Material Jetting
DOD	Drop-on-demand	Process where wax-like liquid and dissolvable support material liquid are jetted selectively	Material Jetting
	Cold spray	Deposition of powder material onto a substrate using pressurized gas, usually at supersonic speeds. The powder particles are not melted but plasticise on impact, forming a solid-state metallurgical bond	Material Jetting
LOM	Laminated Object Manufacturing	Process where layers of adhesive-coated paper, plastic, or metal laminates are successively glued together and cut to shape with a knife or laser cutter.	Sheet lamination
LENS	Laser Engineered Net Shaping	Process where a metal powder is injected into a molten pool created by a focused, high-powered laser beam.	Directed Energy Deposition
	Laser Cladding	A method of depositing material by which a powdered or wire feedstock material is melted and consolidated by use of a laser in order to coat part of a substrate or fabricate a near-net shape part (additive manufacturing technology).	Directed Energy Deposition
LMD	Laser Metal Deposition	A method of depositing material by which a powdered or wire feedstock material is melted and consolidated by use of a laser in order to fabricate a near-net shape part (additive manufacturing technology).	Directed Energy Deposition
DED – Wire plus Arc	Directed Energy Deposition by Wire plus Arc	Wire arc uses an electric arc as a heat source and wire -rather than powder- as feedstock. One of the advantages of this technology is that it can be implemented using off-the-shelf welding equipment, which makes it an appealing option for job shops that don't want to invest in an expensive powder bed system.	Directed Energy Deposition
UAM	Ultrasonic Additive Manufacturing (UAM)	Process where ultrasonic pulses are used to joint thin foils of metals	Sheet lamination

EBAM	Electron Beam Additive Manufacturing	Process where a metal wire is fed into a molten pool created by an electron beam	Directed Energy Deposition
	Joule printing	Process where metal wire is melted and deposited at high speed by resistance heating (Joule effect)	Directed Energy Deposition

Different metal AM technologies use different feedstock (powder, wire, granulate, binder or foils), different energy sources (laser beam, electron beam, electric energy, heat, ultrasonic, kinetics energy) and rely on sintering or melting process.

There are numerous other terms that are used extensively in the AM world. Below is a list:

multi-step process	Type of additive manufacturing process in which parts are fabricated in two or more operations where the first typically provides the basic geometric shape and the following consolidates the part to the fundamental properties of the intended material (metallic, ceramic, polymer or composite).
single-step process	Type of additive manufacturing process in which parts are fabricated in a single operation where the basic geometric shape and basic material properties of the intended product are achieved simultaneously.
hybrid (AM) system	Manufacturing system which combine both additive and subtractive technologies
3D printing	Fabrication of objects through the deposition of a material using a print head, nozzle, or another printer technology.
build chamber	Enclosed location within the additive manufacturing system where the parts are fabricated.
build cycle	Single process cycle in which one or more components are built up in layers in the process chamber of the additive manufacturing system.
build envelope	Largest external dimensions of the x-, y-, and z-axes within the build space where parts can be fabricated.
build platform (of a machine)	Base which provides a surface upon which the building of the part/s, is started and supported throughout the build process.
build space	Location where it is possible for parts to be fabricated, typically within the build chamber or on a build platform.
build surface	Area where material is added, normally on the last deposited layer which becomes the foundation upon which the next layer is formed.
build volume	Total usable volume available in the machine for building parts.

feed region (in powder bed fusion)	Location/s in the machine where feedstock is stored and from which a portion of the feedstock is repeatedly conveyed to the powder bed during the build cycle.
layer	Material laid out, or spread, to create a surface.
overflow region (in powder bed fusion)	Location/s in the machine where excess powder is stored during a build cycle.
process parameters	Set of operating parameters and system settings used during a build cycle.
scanning strategy	Type of pattern used in PBF systems to scan part areas in each layer
hatching space	Distance between adjacent tracks
production run	All parts produced in one build cycle or sequential series of build cycles using the same feedstock batch and process conditions.
G-code	Common name for the most widely used numerical control (NC) programming languages. It is used mainly in computer-aided manufacturing to control automated machine tools. There are many variants, depending on the applications and the technologies used.
system set-up	Configuration of the additive manufacturing system for a build.
3D scanning (3D digitizing)	Method of acquiring the shape and size of an object as a 3-dimensional representation by recording x, y, z coordinates on the object's surface and through software the collection of points is converted into digital data.
bounding box (of a part)	Orthogonally oriented minimum perimeter cuboid that can span the maximum extents of the points on the surface of a 3D part.
initial graphics exchange specification	Platform neutral CAD data exchange format intended for exchange of product geometry and geometry annotation information.
nesting	Situation when parts are made in one build cycle and are located such that their bounding boxes, arbitrarily oriented or otherwise, will overlap.
Product Data Exchange Specification or Product Data Exchange using STEP	An international industry, government, and university consortium committed to accelerating the development and implementation of standards for product data exchange in the Digital Enterprise.

standard for the exchange of product model data	"STEP (standard for the exchange of product model data) is a system-neutral interface format to describe and exchange product model data between different CAD systems. STEP can be used to transfer product data (e.g. colours, text, or layer support) in addition to geometric data (as with DXF or IGES). All forms of CAD data model can be integrated in the geometric representation (wireframe models, surface models, and volume models)."
Additive manufacturing file format (AMF)	The Additive Manufacturing File Format (AMF) is an interchange format developed to address the current and future needs of additive manufacturing technology. It is a file format for communicating additive manufacturing model data including a description of the 3D surface geometry with native support for colour, materials, lattices, textures, constellations and metadata. (ISO/ASTM 52915:2016 provides the specification for the Additive Manufacturing File Format (AMF) Version 1.2.)
3D Manufacturing Format (3MF)	Like AMF a file format dedicated to AM. It uses the same basic approach as AMF but has not made it as an official standard but is used a lot in industry.
Standard Triangulation/Tesselation Language	File format for model data describing the surface geometry of an object as a tessellation of triangles used to communicate 3D geometries to machines in order to build physical parts.
surface model	Mathematical or digital representation of an object as a set of planar or curved surfaces, or both, that can, but does not necessarily have to, represent a closed volume.
curing	Chemical process which results in the ultimate properties of a finish or other material.
feedstock	Bulk raw material supplied to the additive manufacturing building process.
source material (DEPRECATED)	Feedstock.
starting material (DEPRECATED)	Feedstock.
base material (DEPRECATED)	Feedstock.
original material (DEPRECATED)	Feedstock.
part cake	In a powder bed fusion process that uses a heated build chamber lightly bound powder surrounding the fabricated parts at the end of a build cycle.
post-processing	(one or more) Process steps taken after the completion of an additive manufacturing build cycle in order to achieve the desired properties in the final product.

staircase	Stair stepping effect observed in AM parts which greatly depends on AM process layer thickness
powder batch	Powder used as feedstock which could be used powder , virgin powder or a blend of the two.
powder bed	Build area in an additive manufacturing system in which feedstock is deposited and selectively fused by means of a heat source or bonded by means of an adhesive to build up parts.
powder blend	Quantity of powder made by thoroughly intermingling powders originating from one or several powder lots of the same nominal composition.
powder lot	Quantity of powder produced under traceable, controlled conditions, from a single powder manufacturing process cycle.
used powder	Powder that has been supplied as feedstock to an AM machine during at least one previous build cycle.
virgin powder	Unused powder from a single powder lot.
part	Joined material forming a functional element that could constitute all or a section of an intended product.
prototype	Physical representation of all or a component of a product that, although limited in some way, can be used for analysis, design and evaluation.
prototype tooling	Moulds, dies, and other devices used for prototyping purposes; sometimes referred to as bridge tooling or soft tooling.
rapid prototyping	Application of additive manufacturing intended for reducing the time needed for producing prototypes.
as built	Refers to the state of parts made by an additive process before any post processing, besides, if necessary, the removal from a build platform as well as the removal of support and/or unprocessed feedstock.
fully dense	State in which the material of the fabricated part is without significant content of voids.
near net shape	Condition where the components require little post-processing to meet dimensional tolerance.
repeatability	Degree of alignment of two or more measurements of the same property using the same equipment and in the same environment.

<p>KELtool, 3D KELtool</p>	<p>Using an AM part, an RTV Transfer Mold is produced. It is then filled with a thoroughly mixed "slurry" of 70% A6 tool steel powder, tungsten carbide powder, and 30% epoxy binder which is used to bring the two powders together. Once this slurry has cured in the mold, this "green part" is de-molded and is ready for sintering. The green parts are placed into a graphite furnace boat, which is then loaded into a hydrogen-reduction furnace. During sintering the binder material is burned off resulting in a "brown part" that is 70% A6 steel and tungsten carbide, and 30% void (air). The final step is to infiltrate the open spaces in the brown (sintered) part with copper. The resulting part is a fully dense, production mold making insert comprised of 70% A6 tool steel and tungsten carbide, and 30% copper.</p>
<p>Topology optimization</p>	<p>Design tool that allows a prescribed amount of material to be distributed over a given design domain to minimize a scalar objective function for a fixed set of constraints³</p>
<p>Raft</p>	<p>A thick grid with a roof that is added to the base of the part to limit the likelihood of warping occurring. Different to a skirt or brim. Raft is rarely used with heated build surfaces</p>
<p>Brim</p>	<p>A single flat layer printed around the base of a model to prevent warping. The width of the brim can typically be altered in a slicer program.</p>
<p>Warping</p>	<p>Due to the high heat involved in most AM process differential cooling results in areas of a print cooling at different rates resulting in deformation.</p>
<p>Cold-end (or extruder)</p>	<p>A part on an extruder mechanism. The cold end grabs and pulls filament from the spool it is stored on and moves it into the hot end. A typical cold end consists of either a hobbed gear or knurled wheel that is attached to a feeder motor. As the shaft of the motor spins, it rotates the hobbed gear or knurled wheel which grabs the filament and moves it toward the hot end.</p>
<p>Hot-end</p>	<p>A part on an extruder mechanism. The hot end heats the printing filament to melting temperature and extrudes the melted material onto the build surface. A typical hot end consists of a heating block which produces the heat necessary to melt the print filament, a thermistor which controls the temperature of the heating block and a print</p>

³ M. Bruggi, A. Taliercio, 19 - Topology optimization for the development of eco-efficient masonry units, Editor(s): F. Pacheco-Torgal, P.B. Lourenço, J.A. Labrincha, S. Kumar, P. Chindapasirt. Eco-Efficient Masonry Bricks and Blocks, Woodhead Publishing, 2015, Pages 425-445,

	nozzle through which the melted filament is extruded. A heat sink is also typically used to radiate excess heat away from the print end.
Bed leveling	The process of adjusting the bed of a FDM-type printer to insure that it is level and at a right angle to the print head. Bed leveling is critical to obtaining a successfully printed object.
Infill	A value usually represented in percentage that shows how much a solid model should be filled in with material when printed. 100% infill means the part is completely solid. Infill is used to make AM cheaper and faster.
Bringing/bridge	Occurs when the printer is required to print between 2 supports or anchor points. Because there is no support offered for the initial layer being printed (there is nothing to build upon) and it is required to “bridge” a gap.
Skirt	A line that is initially printed around the print (but not connected to the print) to clean the nozzle head.

3. Education terminology

Term	Definition in English	Source	Accessed through
responsibility and autonomy	The ability of the learner to apply knowledge and skills autonomously and with responsibility;	Council recommendation for EQF LLL (2017)	
competence	The proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations, and in professional and personal development.	Council Recommendation of 22 May 2017 on the European Qualifications Framework for lifelong learning and repealing the Recommendation of the European Parliament and of the Council of 23 of April of 2008 on the establishment of the European Qualifications Framework for lifelong learning https://ec.europa.eu/ploteus/sites/eac-efq/files/en.pdf	European Commission ESCO Handbook, European Skills, Competences, Qualifications and Occupations, © European Union, 2017
skill	The ability to apply knowledge and use know-how to complete tasks and solve problems. Skills are described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments).	Council Recommendation of 22 May 2017 on the European Qualifications Framework for lifelong learning and repealing the Recommendation of the European Parliament and of the Council of 23 of April of 2008 on the establishment of the European Qualifications Framework for lifelong learning	European Commission ESCO Handbook, European Skills, Competences, Qualifications and Occupations, ©

		https://ec.europa.eu/ploteus/sites/eac-eqf/files/en.pdf	European Union, 2017
knowledge	The body of facts, principles, theories and practices that is related to a field of work or study. Knowledge is described as theoretical and/or factual, and is the outcome of the assimilation of information through learning.	Council Recommendation of 22 May 2017 on the European Qualifications Framework for lifelong learning and repealing the Recommendation of the European Parliament and of the Council of 23 of April of 2008 on the establishment of the European Qualifications Framework for lifelong learning https://ec.europa.eu/ploteus/sites/eac-eqf/files/en.pdf	European Commission ESCO Handbook, European Skills, Competences, Qualifications and Occupations, © European Union, 2017
know-how	Practical knowledge or expertise	CEDEFOP 2011	CEDEFOP (2008c). Terminology of European education and training policy: a selection of 100 key terms. Luxembourg: Publications Office. Available from Internet: http://europass.cedefop.europa.eu/europass/home/hornav/Glossary.csp
Occupation	a 'set of jobs whose main tasks and duties are characterised by a high degree of similarity'	Source: International Labour Organisation, ILO, International Standard Classification of Occupations (ISCO-08) – Conceptual Framework	European Commission ESCO Handbook, European Skills, Competences, Qualifications and Occupations, © European Union, 2017
Job	a 'set of tasks and duties carried out, or meant to be carried out, by one person for a particular employer, including self-employment	Source: International Labour Organisation, ILO, International Standard Classification of Occupations (ISCO-08) – Conceptual Framework	European Commission ESCO Handbook, European Skills, Competences,

			Qualifications and Occupations, © European Union, 2017
Transversal knowledge, skills and competences	knowledge, skills and competences are relevant to a broad range of occupations and sectors	Council Recommendation of 22 May 2017 on the European Qualifications Framework for lifelong learning and repealing the Recommendation of the European Parliament and of the Council of 23 of April of 2008 on the establishment of the European Qualifications Framework for lifelong learning https://ec.europa.eu/ploteus/sites/eac-eqf/files/en.pdf	European Commission ESCO Handbook, European Skills, Competences, Qualifications and Occupations, © European Union, 2017
Cross-sector knowledge, skills and competences	knowledge, skills and competences that are relevant to occupations across several economic sectors	Council Recommendation of 22 May 2017 on the European Qualifications Framework for lifelong learning and repealing the Recommendation of the European Parliament and of the Council of 23 of April of 2008 on the establishment of the European Qualifications Framework for lifelong learning https://ec.europa.eu/ploteus/sites/eac-eqf/files/en.pdf	European Commission ESCO Handbook, European Skills, Competences, Qualifications and Occupations, © European Union, 2017
Occupation-specific knowledge, skills and competences		Council Recommendation of 22 May 2017 on the European Qualifications Framework for lifelong learning and repealing the Recommendation of the European Parliament and of the Council of 23 of April of 2008 on the establishment of the European Qualifications Framework for lifelong learning https://ec.europa.eu/ploteus/sites/eac-eqf/files/en.pdf	European Commission ESCO Handbook, European Skills, Competences, Qualifications and Occupations, © European Union, 2017
Skill mismatch	Situation of imbalance in which the level or type of skills available does not correspond to labour market needs. Comments: o skills mismatch can be a surplus or a lack of knowledge, abilities and competences;	CEDEFOP 2010.	

	<ul style="list-style-type: none"> o skill mismatch can be analysed at different levels (individual, enterprise, sectoral, economy); o experts distinguish between vertical mismatch (the level of education/skills is higher or lower than required) and horizontal mismatch (the level of education/skills matches job requirements, but the type of education/skills is inappropriate for the current job). 		
Skill shortage	<p>Situation where skills supply (type of abilities and number of people available on the labour market) is not sufficient to meet labour market demand. Comments:</p> <ul style="list-style-type: none"> o a skill shortage applies to all levels of qualification; it may result from factors such as: <ul style="list-style-type: none"> o insufficient education and training supply; o geographical imbalance in supply; o developments impacting the structure of the economy; o lack of attractiveness of specific occupations (difficult working conditions, low remuneration, insufficient social recognition). 	CEDEFOP 2010.	
skill needs	<p>Demand for particular types of skills, competences or qualifications on the labour market (total demand in a country or in a region, economic sector, etc.).</p>	CEDEFOP 2011	<p>CEDEFOP (2008c). Terminology of European education and training policy: a selection of 100 key terms. Luxembourg: Publications Office. Available from Internet: http://europass.cedefop.europa.eu/europass/</p>

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Basic skills	Skills needed to live contemporary society, such as listening, speaking, reading, writing and mathematics.	CEDEFOP 2008	
Green skills	Abilities needed to live in, develop and support a society which aims to reduce the negative impact of human activity on the environment .	CEDEFOP 2008	
Information and communication technology (ICT) skills	Skills needed for efficient use of information and communication technologies.	CEDEFOP, 2004, OECD, Lopez-Bassols, 2002	
Digital competence/digital literacy	Ability to use information and communication technology (ICT). Comment: digital competence is underpinned by basic skills in ICT: use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the internet.	CEDEFOP, 2008; European Parliament and Council of the European Union, 2006	
learning	Process by which an individual assimilates information, ideas and values and thus acquires knowledge, know-how, skills and/or competences.	Commission, 2006a.	CEDEFOP (2008c). Terminology of European education and training policy: a selection of 100 key terms. Luxembourg: Publications Office. Available from Internet: http://europass.cedefop.europa.eu/europass/home/hornav/Glossary.csp
informal learning	Learning resulting from daily activities related to work, family or leisure. It is not organised or structured in terms of objectives, time or learning support. Informal learning is in	CEDEFOP, 2008c.	CEDEFOP (2008c). Terminology of European education and training policy: a

	most cases unintentional from the learner's perspective.		selection of 100 key terms. Luxembourg: Publications Office. Available from Internet: http://europass.cedefop.europa.eu/europass/home/hornav/Glossary.csp
learning-by-doing	Learning acquired by repeated practice of task, with or without prior instruction.	CEDEFOP, 2008c	CEDEFOP (2008c). Terminology of European education and training policy: a selection of 100 key terms. Luxembourg: Publications Office. Available from Internet: http://europass.cedefop.europa.eu/europass/home/hornav/Glossary.csp
learning outcome(s) / learning attainments	Statements regarding what a learner knows, understands and is able to do on completion of a learning process, which are defined in terms of knowledge, skills and responsibility and autonomy.	Commission, 2006a.	CEDEFOP (2008c). Terminology of European education and training policy: a selection of 100 key terms. Luxembourg: Publications Office. Available from Internet: http://europass.cedefop.europa.eu/europass/home/hornav/Glossary.csp
Curriculum	Inventory of activities implemented to design, organise and plan an education or training action, including definition of learning	CEDEFOP 2011	CEDEFOP (2008c). Terminology of European education and

	objectives, content, methods (including assessment) and material, as well as arrangements for training teachers and trainers.		training policy: a selection of 100 key terms. Luxembourg: Publications Office. Available from Internet: http://europass.cedefop.europa.eu/europass/home/hornav/Glossary.csp
teacher	Person whose function is to impart knowledge, know-how or skills to learners in an education or training institution.	CEDEFOP 2011	CEDEFOP (2008c). Terminology of European education and training policy: a selection of 100 key terms. Luxembourg: Publications Office. Available from Internet: http://europass.cedefop.europa.eu/europass/home/hornav/Glossary.csp
trainer	Anyone who fulfils one or more activities linked to (theoretical or practical) training, either in an institution for education or training, or at the workplace.	CEDEFOP 2011	CEDEFOP (2008c). Terminology of European education and training policy: a selection of 100 key terms. Luxembourg: Publications Office. Available from Internet: http://europass.cedefop.europa.eu/europass/home/hornav/Glossary.csp
transferability of learning outcomes	Degree to which knowledge, skills and of learning outcomes competences can be used in a new occupational or educational	CEDEFOP, 2008c	CEDEFOP (2008c). Terminology of European

	environment, and/or be validated and certified.		education and training policy: a selection of 100 key terms. Luxembourg: Publications Office. Available from Internet: http://europass.cedefop.europa.eu/europass/home/hornav/Glossary.csp
assessment of learning outcomes	Process of appraising knowledge, know-how, learning outcomes skills and/or competences of an individual against predefined criteria (learning expectations, measurement of learning outcomes). Assessment is typically followed by validation and certification.	CEDEFOP, 2008c.	CEDEFOP (2008c). Terminology of European education and training policy: a selection of 100 key terms. Luxembourg: Publications Office. Available from Internet: http://europass.cedefop.europa.eu/europass/home/hornav/Glossary.csp
validation of learning outcomes	Confirmation, through provision of objective evidence that the requirements for a specific intended use or application have been fulfilled	ISO, 1994 and ISO, 2000.	CEDEFOP (2008c). Terminology of European education and training policy: a selection of 100 key terms. Luxembourg: Publications Office. Available from Internet: http://europass.cedefop.europa.eu/europass/home/hornav/Glossary.csp

certification of learning outcomes	Process of issuing a certificate, diploma or title of learning outcomes formally attesting that a set of learning outcomes (knowledge, know-how, skills and/or competences) acquired by an individual have been assessed and validated by a competent body against a predefined standard.	CEDEFOP, 2008c.	CEDEFOP (2008c). Terminology of European education and training policy: a selection of 100 key terms. Luxembourg: Publications Office. Available from Internet: http://europass.cedefop.europa.eu/europass/home/hornav/Glossary.csp
indicator	Quantitative or qualitative factor or variable that provides a simple and reliable means to measure achievement, reflect the changes connected to an intervention, or to help assess the performance of a development actor.	OECD, 2002 (cited by CEDEFOP 2011)	CEDEFOP (2008c). Terminology of European education and training policy: a selection of 100 key terms. Luxembourg: Publications Office. Available from Internet: http://europass.cedefop.europa.eu/europass/home/hornav/Glossary.csp
level of qualification	The term covers two aspects: a) the level of attainment in education and training recognised in a qualification system or in a qualification framework; or b) the learning outcomes acquired through education and training, work experience or in informal/ non-formal settings.	CEDEFOP 2011	CEDEFOP (2008c). Terminology of European education and training policy: a selection of 100 key terms. Luxembourg: Publications Office. Available from Internet: http://europass.cedefop.europa.eu/europass/

			home/hornav/ Glossary.csp
formal learning	Learning that occurs in an organised and structured environment (in an education or training institution or on the job) and is explicitly designated as learning (in terms of objectives, time or resources). Formal learning is intentional from the learner's point of view. It typically leads to validation and certification.	CEDEFOP, 2008c.	CEDEFOP (2008c). Terminology of European education and training policy: a selection of 100 key terms. Luxembourg: Publications Office. Available from Internet: http://europass.cedefop.europa.eu/europass/home/hornav/Glossary.csp
non-formal learning	Learning which is embedded in planned activities not explicitly designated as learning (in terms of learning objectives, learning time or learning support). Non-formal learning is intentional from the learner's point of view.	CEDEFOP, 2008c	CEDEFOP (2008c). Terminology of European education and training policy: a selection of 100 key terms. Luxembourg: Publications Office. Available from Internet: http://europass.cedefop.europa.eu/europass/home/hornav/Glossary.csp
work-based learning	Acquisition of knowledge and skills through carrying out – and reflecting on – tasks in a vocational context, either at the workplace (such as alternating training) or in a VET institution.	CEDEFOP 2011	CEDEFOP (2008c). Terminology of European education and training policy: a selection of 100 key terms. Luxembourg: Publications Office. Available from Internet:

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Workload	An estimation of the time learners typically need to complete all learning activities such as lectures, seminars, projects, practical work, work placements, individual study required to achieve the defined learning outcomes in formal learning environments. The correspondence of the full-time workload of an academic year to 60 credits is often formalised by national legal provisions.	ECTS Users' Guide, 2015.	
lifelong learning	All learning activity undertaken throughout life, which results in improving knowledge, knowhow, skills, competences and/or qualifications for personal, social and/or professional reasons.	CEDEFOP, 2008c; European Commission, 2001	CEDEFOP (2008c). Terminology of European education and training policy: a selection of 100 key terms. Luxembourg: Publications Office. Available from Internet: http://europass.cedefop.europa.eu/europass/home/hornav/Glossary.csp
programme of education or training	Inventory of activities, content and/or methods education or training implemented to achieve education or training objectives (acquiring knowledge, skills and/or competences), organised in a logical sequence over a specified period of time	CEDEFOP, 2008c.	CEDEFOP (2008c). Terminology of European education and training policy: a selection of 100 key terms. Luxembourg: Publications Office. Available from Internet: http://europass.cedefop.europa.eu/europass/

			home/hornav/ Glossary.csp
qualification	<p>Qualification covers different aspects:</p> <p>(a) formal qualification: the formal outcome (certificate, diploma or title) of an assessment and validation process, which is obtained when a competent body determines that an individual has achieved learning outcomes to given standards and/or possesses the necessary competence to do a job in a specific area of work. A qualification confers official recognition of the value of learning outcomes in the labour market and in education and training. A qualification can be a legal entitlement to practice a trade (OECD⁴);</p> <p>(b) job requirements: knowledge, aptitudes and skills required to perform specific tasks attached to a particular work position (ILO⁵).</p>	CEDEFOP 2011	CEDEFOP (2008c). Terminology of European education and training policy: a selection of 100 key terms. Luxembourg: Publications Office. Available from Internet: http://europass.cedefop.europa.eu/europass/home/hornav/Glossary.csp
Qualification system:	<p>All activities related to the recognition of learning outcomes and other mechanisms that link education and training to the labour market and civil society. These activities include:</p> <ul style="list-style-type: none"> ○ definition of qualification policy, training design and implementation, institutional arrangements, funding, quality assurance; ○ assessment and certification of learning outcomes. <p>Comment: a national qualifications system may be composed of several subsystems and may include a national qualifications framework.</p>	CEDEFOP, 2008; European Parliament and Council of the European Union, 2008.	

⁴ OECD: The Organisation for Economic Co-operation and Development (www.oecd.org)

⁵ ILO: The International Labour Organization (www.ilo.org)

International Qualification	qualification awarded by a legally established international body (association, organisation, sector or company) or by a national body acting on behalf of an international body that is used in more than one country and that includes learning outcomes assessed with reference to standards established by an international body;	Council recommendation for EQF LLL (2017)	
accreditation	Formal recognition that a body or a person is competent to carry out specific tasks.	ISO Glossary	CEDEFOP (2008c). Terminology of European education and training policy: a selection of 100 key terms. Luxembourg: Publications Office. Available from Internet: http://europass.cedefop.europa.eu/europass/home/hornav/Glossary.csp
qualification framework	Instrument for development and classification of qualifications (at national or sectoral levels) according to a set of criteria (such as using descriptors) applicable to specified levels of learning outcomes.	CEDEFOP 2011	CEDEFOP (2008c). Terminology of European education and training policy: a selection of 100 key terms. Luxembourg: Publications Office. Available from Internet: http://europass.cedefop.europa.eu/europass/home/hornav/Glossary.csp

<p>European Qualifications Framework European Qualifications Framework (EQF):</p>	<p>A common European reference tool that serves as a translation device between different education and training systems and their levels. It aims to improve the transparency, comparability and portability of qualifications across Europe, promoting workers' and learners' mobility and facilitating their lifelong learning.</p>	<p>2008/EC 111/01 Recommendation of the European Parliament and the Council.</p>	<p>Council Recommendation for EQF 2008</p>
<p>National qualifications framework (NQF)</p>	<p>Instrument for the classification of qualifications according to a set of criteria for specified levels of learning achieved, which aims at integrating and coordinating national qualifications subsystems and improve the transparency, access, progression and quality of qualifications in relation to the labour market and civil society;</p>	<p>Source: Council recommendation for EQF LLL (2017)</p>	
<p>European Credit Transfer and Accumulation System (ECTS)</p>	<p>A systematic way of describing a higher education programme by attaching credits to its components (modules, courses, placements, dissertation work, etc), to:</p> <ul style="list-style-type: none"> o Make study programmes easy to read and compare for all students, local and foreign; o encourage mobility of students and validation of learning outcomes; o Help universities to organise and revise their study programmes <p>Comments: ECTS is based on the student workload required to achieve programmes' objectives, specified in terms of learning outcomes to be acquired.</p>	<p>CEDEFOP, 2008, Based on European Commission 2004</p>	

<p>European Credit System for Vocational Education and Training (ECVET)</p>	<p>Technical framework for transfer, validation and, where appropriate, accumulation of learning outcomes by individuals, to achieve a qualification. ECVET tools and methodology comprise a description of qualifications in units of learning outcomes with associated points, a transfer and accumulation process and complementary documents such as learning agreements, transcripts of records and ECVET user's guides.</p>	<p>CEDEFOP, European Parliament Council of European Union, 2009a</p>	
<p>Multilingual classification of European Skills, Competences, Qualifications and Occupations (ESCO)</p>	<p>Identifies and categorizes skills and competences, qualifications and occupations relevant for the EU labour market and education and training, in 25 European languages. The system provides occupational profiles showing the relationships between occupations, skills, competences and qualifications. ESCO has been developed in an open IT format and is available for everyone to use free of charge.</p>	<p>https://ec.europa.eu/esco/portal/home</p>	
<p>Europass</p>	<p>Portfolio of five different documents and an electronic folder aiming to contain descriptions of the entire holder's learning achievements, official qualifications, work experience, skills and competences, acquired over time. These documents are: the Europass CV, the Diploma Supplement, the Certificate Supplement, the Europass Mobility and the Language Passport. Europass also includes the European Skills Passport, a user-friendly electronic folder that helps the holder to build up a personal, modular inventory of his/her skills and qualifications. The aim of Europass is to facilitate mobility and improve job and lifelong learning prospects in Europe.</p>	<p>Adapted from CEDEFOP</p>	

unit of learning outcomes (ECVET)	Set of knowledge, skills, and/or competences outcomes (ECVET) which constitute a coherent part of a qualification. A unit can be the smallest part of a qualification that can be assessed, transferred, validated and, possibly, certified. A unit can be specific to a single qualification or common to several qualifications.	European Parliament and Council of the European Union (2009b).	CEDEFOP (2008c). Terminology of European education and training policy: a selection of 100 key terms. Luxembourg: Publications Office. Available from Internet: http://europass.cedefop.europa.eu/europass/home/hornav/Glossary.csp
upskilling	Short-term targeted training typically provided following initial education or training, and aimed at supplementing, improving or updating knowledge, skills and/or competences acquired during previous training.	CEDEFOP, 2008c.	CEDEFOP (2008c). Terminology of European education and training policy: a selection of 100 key terms. Luxembourg: Publications Office. Available from Internet: http://europass.cedefop.europa.eu/europass/home/hornav/Glossary.csp
vocational education and training (VET)	Education and training which aim to equip and training (VET) people with knowledge, know-how, skills and/or competences required in particular occupations or more broadly on the labour market.	CEDEFOP 2011	CEDEFOP (2008c). Terminology of European education and training policy: a selection of 100 key terms. Luxembourg: Publications Office. Available from Internet: http://europass.cedefop.europa.eu/europass/

			home/hornav/ Glossary.csp
regulated profession	Occupation with associated legal requirements, regulated by Member States, at European Level	adapted	European Commission ESCO Handbook, European Skills, Competences, Qualifications and Occupations, © European Union, 2017
sector-specific knowledge, skills and competences	knowledge, skills and competences are specific to one sector, but are relevant for more than one occupation within that sector	Council Recommendation of 22 May 2017 on the European Qualifications Framework for lifelong learning and repealing the Recommendation of the European Parliament and of the Council of 23 of April of 2008 on the establishment of the European Qualifications Framework for lifelong learning https://ec.europa.eu/ploteus/sites/eac-eqf/files/en.pdf	European Commission ESCO Handbook, European Skills, Competences, Qualifications and Occupations, © European Union, 2017

4. SAM specific terminology and concepts ⁶

AM Observatory	<p>centralised unit working as a team and platform for the AM skills identification, assessment and validation.</p> <p>Comments: [“Observatory” meaning:]</p> <ul style="list-style-type: none"> • Establish a sustainable and dynamic framework for AM skills • Dynamic and agile Framework to enable coordinated activities and initiatives across Europe, sectors, supply chains. • Providing orientation in AM skills to European companies (what skills are needed to do what; what needed today, tomorrow etc etc) • Quality assurance system within Framework to ensure quality of skills training in all aspects (skills profile, training content, trainer skills) • Framework to enable delivery of AM skills for European industry <ul style="list-style-type: none"> ○ Timely (when needed, or need emerging) <ul style="list-style-type: none"> ○ With quality needed, according to industry requirements across Europe ○ Reflecting sector needs ○ Ensuring easy access for all sizes of companies
Forecasting	<p>Quantitative forecasts are statistical projections, econometric models or similar methods that produce information on aspects of future labour markets (supply and demand, skills, qualifications etc). Forecasts use data about the present and past to estimate future developments. Source: CEDEFOP & ETF vol.2, 2017</p>
Roadmapping	<p>Normative method that aims to look at the future for a chosen field and to identify the most important drivers changes in that field (JRC-IPTS). It provides inputs for the formulation of policies and strategies (UNIDO). Source: CEDEFOP & ETF vol.2, 2017</p>
Scope of scenarios	<ul style="list-style-type: none"> • Real-case scenarios, to be addressed in less than 6 months • Short -term scenarios, to be addressed in less than 2 years • Foresight scenarios, to be addressed in 10 years,

⁶ Source: SAM project