ISO/ASTM 52900:2021(E)

Additive manufacturing — General principles — Fundamentals and vocabulary[1,2]

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INTRODUCTION

Additive manufacturing (AM) is the general term for those technologies that successively join material to create physical objects as specified by 3D model data. These technologies are presently used for various applications in engineering industry as well as other areas of society, such as medicine, education, architecture, cartography, toys and entertainment.

During the development of additive manufacturing technology, there have been numerous different terms and definitions in use, often with reference to specific application areas and trademarks. This is often ambiguous and confusing, which hampers communication and wider application of this technology.

It is the intention of this document to provide a basic understanding of the fundamental principles for additive manufacturing processes, and based on this, to give clear definitions for terms and nomenclature associated with additive manufacturing technology. The objective of this standardization of terminology for additive manufacturing is to facilitate communications between people involved in this field of technology on a worldwide basis.

1. Scope

1.1 This document establishes and defines terms used in additive manufacturing (AM) technology, which applies the additive shaping principle and thereby builds physical three-dimensional (3D) geometries by successive addition of material.

1.2 The terms have been classified into specific fields of application.

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Normative references

2.1 There are no normative references in this document.

3. Terms and definitions

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

– ISO Online browsing platform: available at https://www.iso.org/obp
– IEC Electropedia: available at http://www.electropedia.org/

3.1 *Definitions:*

General terms

3D printer, *n*—machine used for **3D printing**.

additive manufacturing (AM), *n*—process of joining materials to make **parts** from 3D model data, usually **layer** upon layer, as opposed to subtractive manufacturing and formative manufacturing methodologies.

DISCUSSION—Historical terms include: additive fabrication, additive processes, additive techniques, additive layer manufacturing, layer manufacturing, solid freeform fabrication and freeform fabrication.

DISCUSSION—The meaning of "additive-", "subtractive-" and "formative-" manufacturing methodologies is further discussed in Annex A2.

additive system, *n*—
additive manufacturing system
additive manufacturing equipment
machine and auxiliary equipment used for **additive manufacturing**.

AM machine, *n*—section of the **additive manufacturing system** including hardward, machine control software, required set-up software and peripheral accessories necessary to complete a **build cycle** for producing **parts**.

[1] This international standard is under the jurisdiction of Committee F42 on Additive Manufacturing Technologies and is the direct responsibility of Subcommittee F42.91 on Terminology, and is also under the jurisdiction of ISO/TC 261, Additive manufacturing, on the basis of a partnership agreement between ISO and ASTM International with the aim to create a common set of ISO/ASTM standards on additive manufacturing.

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[2] Through a mutual agreement with ASTM International (ASTM), the Society of Manufacturing Engineers (SME) contributed the technical expertise of its RTAM Community members to ASTM to be used as the technical foundation for this ASTM standard. SME and its membership continue to play an active role in providing technical guidance to the ASTM standards development process.

AM machine user, *n*—operator of or entity using an **AM machine**.

AM system user, *n*—
additive system user
operator of or entity using an entire **additive manufacturing system** or any component of an **additive system**.

front, *n—of a machine, unless otherwise designated by the machine builder*, side of the machine that the operator faces to access the user interface or primary viewing window, or both.

material supplier, *n*—provider of material/**feedstock** to be processed in an **additive manufacturing system**.

multi-step process, *n*—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.

Discussion—Fundamental properties of the intended product material are typically metallic properties for intended metallic products, ceramic properties for intended ceramic products, polymer properties for intended polymer (plastic) products and composite material properties for products intended to be made of a composite material.

Discussion—Removal of the support structure and cleaning can many times be necessary; however, in this context, this operation is not considered as a separate process step.

Discussion—The principle of **single-step** and multi-step processes is further discussed in Annex A2.

single-step process, *n*—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.

Discussion—Removal of the support structure and cleaning can many times be necessary; however, in this context, this operation is not considered as a separate process step.

Discussion—The principle of single-step and **multi-step processes** is further discussed in Annex A2.

3.2 *Definitions:*

Process categories

binder jetting (BJT), *n*—**additive manufacturing** process in which a liquid bonding agent is selectively deposited to join powder materials.

Discussion—Identification of different binder jetting processes shall be consistent with the method described in Annex A1.

directed energy deposition (DED), *n*—**additive manufacturing** process in which focused thermal energy is used to fuse materials by melting as they are being deposited.

Discussion—"Focused thermal energy" means that an energy source (for example, laser, electron beam or plasma arc) is focused to melt the materials being deposited.

Discussion—Identification of different directed energy deposition processes shall be consistent with the method described in Annex A1.

material extrusion (MEX), *n*—**additive manufacturing** process in which material is selectively dispensed through a nozzle or orifice.

Discussion—Identification of different material extrusion processes shall be consistent with the method described in Annex A1.

material jetting (MJT), *n*—**additive manufacturing** process in which droplets of feedstock material are selectively deposited.

Discussion—Example feedstock materials for material jetting include photopolymer resin and wax.

Discussion—Identification of different material jetting processes shall be consistent with the method described in Annex A1.

powder bed fusion (PBF), *n*—**additive manufacturing** process in which thermal energy selectively fuses regions of a **powder bed**.

Discussion—Identification of different powder bed fusion processes shall be consistent with the method described in Annex A1.

sheet lamination (SHL), *n*—**additive manufacturing** process in which sheets of material are bonded to form a **part**.

Discussion—Identification of different sheet lamination processes shall be consistent with the method described in Annex A1.

vat photopolymerization (VPP), *n*—**additive manufacturing** process in which liquid photopolymer in a vat is selectively cured by light-activated polymerization.

Discussion—Identification of different vat photopolymerization processes shall be consistent with the method described in Annex A1.

3.3 *Definitions:*

Processing: general

3D printing, *n*—fabrication of objects through the deposition of a material using a print head, nozzle, or another printer technology.

Discussion—This term is often used in a non-technical context synonymously with **additive manufacturing** and, in these cases, typically associated with machines used for non-industrial purposes including personal use.

build chamber, *n*—enclosed location within the **additive manufacturing system** where the **parts** are fabricated.

build cycle, *n*—single process cycle in which one or more components are built by successive joining of material within the **build space** of the **additive manufacturing system**.

build platform, *n—of a machine*, base which provides a surface upon which the building of the **parts** is started and supported throughout the build process.

Discussion—In some systems, the **parts** are built attached to the build platform, either directly or through a **support** structure. In other systems, such as certain types of **powder bed** systems, a direct mechanical fixture between the part and the build platform is not necessarily required.

build space, *n*—location where it is possible for **parts** to be fabricated, typically within the **build chamber** or on a **build platform**.

build surface, *n*—area where material is added, normally on the last deposited **layer** which becomes the foundation upon which the next layer is formed.

Discussion—For the first layer, the build surface is often the **build platform**.

DISCUSSION—In the case of **directed energy deposition** processes, the build surface can be an existing part onto which material is added.

DISCUSSION—If the orientation of the material deposition or consolidation means, or both, is (are) variable, it may be defined relative to the build surface.

build volume, *n*—total usable volume available in the machine for building **parts**.

layer, *n*—*matter*, material laid out, or spread, to create a surface.

manufacturing lot, *n*—set of manufactured **parts** having commonality between **feedstock**, **production run**, **additive manufacturing system**, and **post-processing** steps (if required) as recorded on a single manufacturing work order.

DISCUSSION—The additive manufacturing system can include one or several **AM machines** and/or post-processing machine units, as agreed by **AM** provider and customer.

manufacturing plan, *n*—document setting out the specific manufacturing practices, technical resources and sequences of activities relevant to the production of a particular product including any specified acceptance criteria at each stage.

DISCUSSION—For **additive manufacturing**, the manufacturing plan typically includes, but is not limited to, **process parameters**, preparation and **post processing** operations as well as relevant verification methods.

DISCUSSION—Manufacturing plans are typically required under a quality management system such as ISO 9001(**1**)[3] and ASQ C1(**2**).

process chain, *n*—sequence of operations necessary for the **part** to achieve desired functionality and properties.

process parameters, *n*—operating parameters and system settings used during a **build cycle**.

production run, *n*—set of all **parts** produced in one **build cycle** or sequential series of build cycles using the same **feedstock** batch and process conditions.

support, *n*—structure separate from the **part** geometry that is created to provide a base and anchor for the part during the building process.

DISCUSSION—Supports are typically removed from the part prior to use.

DISCUSSION—For certain processes such as **material extrusion** and **material jetting**, the support material can be different from the part material and deposited from a separate nozzle or print head.

DISCUSSION—For certain processes such as metal **powder bed fusion** processes, auxiliary supports can be added to serve as an additional heat sink for the part during the building process.

system set-up, *n*—configuration of the **additive manufacturing system** for a build cycle.

3.4 *Definitions:*

Processing: data

3D scanning, *n*—
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 converting the collection of points into digital data.

DISCUSSION—Typical methods use some amount of automation, coupled with a touch probe, optical sensor or other device.

DISCUSSION—In additive manufacturing process chains, 3D scanning can typically be used for generation of surface models, in situ monitoring, non-destructive testing, as well as verification of the part geometry.

Additive Manufacturing File Format (AMF), *n*—file format for communicating **additive manufacturing** model data including a description of the 3D surface geometry with native support for color, materials, lattices, textures, constellations and metadata.

DISCUSSION—Additive Manufacturing File Format (AMF) can represent one of multiple objects arranged in a constellation. Similar to **STL**, the surface geometry is represented by a triangular mesh, but in AMF the triangles can also be curved. AMF can also specify the material and color of each volume and the color of each triangle in the mesh. ISO/ASTM 52915(**3**) gives the standard specification of AMF.

AMF consumer, *n*—software reading (parsing) the **AMF** file for fabrication, visualization or analysis.

DISCUSSION—AMF files are typically imported by **additive manufacturing equipment**, as well as viewing, analysis and verification software.

AMF editor, *n*—software reading and rewriting the **AMF** file for conversion.

DISCUSSION—AMF editor applications are used to convert an AMF from one form to another, for example to convert all curved triangles to flat triangles or convert porous material specification into an explicit mesh surface.

AMF producer, *n*—software writing (generating) the **AMF** file from original geometric data.

DISCUSSION—AMF files are typically exported by CAD software, scanning software or directly from computational geometry algorithms.

attribute, *n*—*data*, characteristic representing one or more aspects, descriptors or elements of the data.

DISCUSSION—In object-oriented systems, attributes are characteristics of objects. In Extensible Markup Language (XML(**4**)), attributes are characteristics of **elements**.

DISCUSSION—In the **AMF**-file, attributes can, for example, be used to carry notices enabling backwards traceability to CAD components, or markers that allow track and trace mechanisms for the file.

comment, *n*—*data*, remark in source code which does not affect the behavior of the program.

DISCUSSION—Comments are used for enhancing human readability of the file and for debugging purposes.

DISCUSSION—In the **AMF**-file, comments can, for example, be used to carry material specification or notices enabling backwards traceability to CAD components.

element, *n*—information unit within an XML(**4**) document consisting of a start tag, an end tag, the content between the tags and any **attributes**.

DISCUSSION—In the XML framework of **AMF**, an element can contain data, attributes structures such as constellations, as well as including other elements.

[3] The boldface numbers in parentheses refer to a bibliography at the end of this standard.