# INTEGRATING 3D PRINTING PARAMETERS INTO TECHNICAL DRAWINGS: A FRAMEWORK FOR SEAMLESS ADDITIVE MANUFACTURING

Faust Séculi, Fernando Julián, F. Xavier Espinach, Manel Alcalà and Joan Ximinis

Universitat de Girona. Escola Politècnica Superior (Spain)

DOI: https://dx.doi.org/10.6036/11494

**ABSTRACT:**

*3D printing, or additive manufacturing, has become a transformative technology that enables rapid prototyping, customized production, and the creation of complex geometries unattainable through traditional methods. It is widely used in aerospace, healthcare, automotive, and consumer industries, offering cost-effective and efficient production solutions. However, a critical gap remains: 3D printing parameters are rarely integrated into technical drawings, leading to a disconnect between digital design and physical manufacturing.*

*Incorporating 3D printing data into technical drawings is essential to streamline the transition from digital models to physical parts. While conventional drawings include fabrication details such as tolerances and material specifications, they lack the parameters necessary for additive manufacturing. This research proposes a framework to embed key 3D printing parameters—such as layer height, printing speed, infill density, support structures, extrusion temperature, and cooling settings—directly within technical drawings.*

*To achieve this, a standardized annotation system should be developed, similar to conventions used in machining and casting. Such a system would define how 3D printing information is encoded within CAD-generated drawings, ensuring consistency across software and production environments. Like geometric dimensioning and tolerancing (GD&T) in CNC machining, this framework would allow engineers to convey precise additive manufacturing instructions through an extended metadata layer or specialized symbols, reducing the need for separate process sheets.*

*Integrating these annotations into common CAD formats like STEP and IGES would enhance interoperability and communication between design and production teams. By embedding 3D printing parameters directly into technical drawings, manufacturers can minimize errors, improve repeatability, and accelerate workflows. This approach strengthens the link between design intent and fabrication, promoting a more seamless and standardized implementation of additive manufacturing.*

***Keywords:*** *3D printing, Additive manufacturing, Technical drawing, 3D modelling, Dimensioning rules*

## 1. INTRODUCTION

Additive Manufacturing, or 3D printing, has transformed industries such as aerospace, healthcare, automotive, and consumer goods by enabling complex geometries, rapid prototyping, and customized production [1]. This technology offers design flexibility and personalization beyond traditional manufacturing methods [2, 3]. Despite its growing adoption, a key challenge remains: the integration of essential 3D printing parameters [4] into technical drawings [5]. This disconnection can cause misinterpretations, compromising the quality and accuracy of manufactured parts [6].

To address this, technical drawings must include AM-specific data—layer height, nozzle diameter, print speed, infill density, support structures, extrusion temperature, and cooling settings—to bridge the gap between digital design and physical production [7]. These variables significantly influence a part's mechanical performance, dimensional fidelity, and functional quality [8]. However, conventional CAD drawings typically lack this critical information.

A standardized annotation system—comparable to Geometric Dimensioning and Tolerance (GD&T) in subtractive manufacturing—is proposed to integrate AM parameters directly into drawings. This system would include a dedicated 3D printing data block and specialized symbols to encode key parameters [9, 10], ensuring consistency across platforms and enhancing communication between designers and manufacturers [11].

Equally important is the differentiation of external perimeters and internal infill in technical representations. These structural regions affect strength, weight, and print efficiency and must be clearly illustrated. Additionally, standardized test specimens, as per ASTM or ISO protocols, should be integrated into drawings. These specimens enable mechanical testing for properties such as tensile strength and hardness, ensuring material traceability and process validation [12].

As generative design increases the complexity of geometries, conventional inspection methods face limitations. Incorporating metrological annotations [13], such as designated inspection zones—during the design phase allows for integrated quality control. Standardizing parameters like printer type, material characteristics, and test protocols further enhances repeatability and product reliability.

This work supports international standards (e.g., ISO 7200, ISO 129, ISO 1101, ISO 128) to formalize technical annotations for AM. It emphasizes critical factors such as print parameter tables, seam locations, perimeter-free surfaces, and post-processing needs, which are essential for ensuring dimensional precision and functional performance. Integrating these parameters into technical drawings and converting them into standard CAD formats (e.g., STEP, IGES) improves design-to-manufacturing interoperability, reduces errors, and streamlines workflows. The proposed framework fosters efficient production transitions, supporting industrial-scale adoption of additive manufacturing and enabling high-precision, customizable fabrication.
The aim of this article is to develop a standardized framework for integrating key 3D printing parameters into technical drawings, with the goal of ensuring applicability across different additive manufacturing technologies. While the proposed framework illustrates its implementation through selected parameters which may be more relevant to certain, the structure is designed to be flexible and adaptable to any 3D printing method. By formalizing the graphical representation of print-specific data within CAD-generated drawings, this approach enhances communication, consistency, and interoperability across the entire design-to-production workflow.

## 2. TERMS AND PARAMETERS DEFINITION

The integration of 3D printing parameters into technical drawings follows established standards, similar to those used for composite materials in aerospace applications, and requires distinguishing between outer perimeters and internal infill. Outer surfaces affect dimensional accuracy and depend on parameters like layer height and extrusion speed, while infill structures are optimized for strength and efficiency. Designs exposing internal structures demand precise graphical representation using standardized symbology, sectional views, and annotations.

### 2.1.GENERAL TERMS

The following technical terms, used throughout this work, are defined as follows:
**Printing Type:** Specifies the 3D printing technology (according to ISO/ASTM 52900) to be used, including: FDM (Fused Deposition Modeling) that utilizes filament-based extrusion, FGF (Fused Granular Fabrication) employing granulated materials, vat photopolymerization (Stereolithography), powder bed fusion, binder jetting, material jetting, sheet lamination, and directed energy deposition (DED).
**Printing Material:** Specifies the material to be used in the 3D printing process. Common materials include PLA (Polylactic Acid), ABS (Acrylonitrile Butadiene Styrene), PETG (Polyethylene Terephthalate Glycol), Nylon, TPU (Thermoplastic Polyurethane), Standard Resin, Flexible Resin, Tough Resin, High-Temperature Resin [14].
**Specimen Requirement:** Indicates whether a test specimen is required for material characterization and traceability purposes.
**Specimen Type:** If a test specimen is required, the specific type should be defined according to the mechanical or functional tests to be performed (e.g., tensile, flexural, acoustic), and in accordance with relevant standards.

### 2.2. PRINTING CONFIGURATION TERMS

The following technical parameters are defined for 3D printing configuration [15], including relevant units of measurement:
**Layer Height** [mm]: The thickness of each individual layer deposited during the printing process. It affects the Print Time and the Vertical Resolution.
**First Layer Height** [mm]: thickness of the first layer (can improve bed adhesion).
**Perimeters** [Count]: Refers to the number of outer contour lines forming the wall of the model. Mechanical strength of the printed object relies more on perimeter count than infill percentage.
**Vase Mode** [Enabled/Disabled]: Activates a continuous, single-wall print path with gradually increasing Z-height, eliminating visible layer seams and weak points due to retractions.
**Top Solid Layers** [Count & Thickness]: Specifies the number and minimum thickness of fully solid layers at the top of the model (100% infill).
**Bottom Solid Layers** [Count & Thickness]: Specifies the number and thickness of fully solid layers at the bottom of the model (100% infill).
**Seam Position** [Aligned/Random/Rear/Front]: Determines the location of the start point for each perimeter line, affecting the visual appearance of the seam on the model's surface (Fig. S1).
**Fuzzy Skin** [Enabled/Disabled]: Applies a rough texture to the outer surface, improving grip (e.g., for tools) or concealing surface imperfections.


ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

**Infill Density** [%]: Indicates the percentage of material filled inside the object (Fig. S2).
**Infill Pattern** [Rectilinear, Hexagonal, etc. as shown in Fig.S3]: Internal structural pattern of the infill, which affects printing speed, material consumption, mechanical stability, surface support, aesthetic appearance, flexibility (e.g., for TPU or TPE materials).
**Top/Bottom Infill Patterns**: Defines the structural pattern used exclusively for the top and bottom layers, independent of internal infill configuration.
**Printing Speed** [mm/s]: Defines the speed of the extruder head during the printing process. Important related parameters include printing speed, retraction speed, travel speed (non-extrusion move).
**Raster Angle** [º]: The direction in which infill lines are deposited within each layer.
**Skirt** [Enabled/Disabled]: A pre-print perimeter line around the model to prime the nozzle and assess bed adhesion (Fig. S4).
**Skirt Distance** [mm]: Distance between the skirt and the actual part.
**Skirt Type**: Specifies the structure type for the skirt: skirt, brim, raft.
**Skirt Width**: The number of lines printed around the model in the skirt/brim structure.
**Support Material** [Enabled/Disabled]: Activates the generation of auxiliary structures for overhangs and unsupported features.
**Support Type**:

- Normal: Standard rectangular columns.
- Tree: Optimized branching structures that reduce material use.
- Soluble: Designed to be dissolved in post-processing.

## 2.3. FILAMENT CONFIGURATION TERMS

This section defines the technical parameters for filament configuration, including corresponding units of measurement and setup values [16, 17].
**Filament Diameter** [mm]: Specifies the thickness of the material fed into the printer for layer-by-layer deposition.
**Filament Density** [g/cm³]: Represents the mass per unit volume of the printing material, depending on its composition.
**First Layer Nozzle Temperature** [°C]: The extrusion temperature applied at the nozzle for the first printed layer. Typically set higher than subsequent layers to enhance adhesion to the build plate.
**Subsequent Layers Nozzle Temperature** [°C]: The nozzle temperature during the printing of layers after the first. Often reduced slightly (typically by 5°C) to improve surface quality and prevent defects.
**First Layer Bed Temperature** [°C]: The temperature of the heated bed during deposition of the first layer. It ensures proper adhesion to the build surface and minimizes warping.
**Subsequent Layers Bed Temperature** [°C]: The heated bed temperature for the remainder of the print.

## 2.4. PRINTER CONFIGURATION TERMS

This section defines the technical parameters associated with printer configuration, including relevant units and operational considerations [18].
**Nozzle Diameter** [mm]: Refers to the diameter of the extrusion orifice through which molten filament is deposited. This parameter directly influences print resolution, deposition rate, and overall print time.
**Z-Hop** (Travel Lift) [mm]: The vertical displacement of the nozzle before non-extrusion travel moves. This prevents collisions with the printed part and minimizes surface defects.
**Retraction Length** [mm]: The distance the extruder pulls the filament back prior to a travel move, preventing stringing or oozing during non-print moves.
**Cooling** (Fan Speed) [Enabled/Disabled]: Refers to the activation and control of active cooling systems.
**Bed Adhesion Method**: Indicates whether an external adhesion aid is applied to the print bed.
**Print Bed Surface Finish** (Bed Surface): Describes the texture and visual characteristics of the first printed layer, which depends on the bed surface material.

# 3. PARAMETERS SPECIFICACTIONS AND NORMS IN TECHNICAL DRAWING

The definition of an additively manufactured component includes both its geometric representation—following standardized technical drawing conventions—and its schematic depiction in accordance with regulatory guidelines. It must also integrate complementary specifications beyond the printing process, such as post-processing requirements, quality control measures, and material


ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

characterization and traceability. These elements are essential for ensuring the part's functional performance, reliability, and compliance with relevant standards.

## 3.1. PARAMETERS LIST

The representation and use of the parameter table follow ISO 7200 guidelines. Dimensional tolerances adhere to ISO 129, ISO 6403, and ISO 1101, unless otherwise specified. Manufacturing conditions are defined by reference documents, with the technical drawing as the primary normative source. The parameter table is typically placed at the top of the drawing sheet but may be relocated as needed, provided clarity and part identification are maintained.

## 3.2. POST 3D PRINTING OPERATIONS

3D printing produces complex, precise geometries but often requires post-processing like machining or surface finishing to address inherent limitations. Operations such as drilling and surface treatment improve part quality and functionality. These interventions are needed due to resolution and dimensional accuracy constraints, functional demands for high-precision fits, and material properties that may require enhanced strength, durability, or thermal stability.

### 3.2.1. Applicable Standards for the Representation of Post-Processing Operations

The accurate representation of post-processing operations in technical drawings must adhere to standardized documentation protocols to ensure unambiguous interpretation throughout the manufacturing process. The principal applicable standards include:

- ISO 128-20
- ISO 1101
- ISO 2768-1 and ISO 2768-2
- ISO 10110 and ASME Y14.
- UNE-EN ISO 1302

### 3.2.2. Graphical Symbols for Post-Processing Representation

Standardized graphical symbols are utilized to communicate the required post-processing modifications to manufacturing personnel. Key symbols include:

- Drilling and Threading: Represented according to ISO 6410, specifying nominal diameter, depth, thread type (metric or imperial), and any additional pertinent details.
- Surface Finishing: Indicated using the symbols defined in ISO 1302.
- Geometric Tolerances: Denoted by symbols per ISO 1101.
- Critical Dimensions: Specified according to ISO 286 or ASME Y14.5, including center-to-center fits, total heights, thicknesses, and any other parameters requiring enhanced precision.

### 3.2.3. Implementation in Drawings for Additive Manufacturing

In the context of technical drawings for additive manufacturing, it is essential to clearly distinguish between dimensions obtained directly through the printing process and those requiring subsequent machining. Recommended practices include:

- Annotations and Operation Tables: Clearly indicating which features will undergo post-processing.
- Sectional and Enlarged Views: Providing visual clarity for complex or critical details.
- Color Coding or Pattern Differentiation: If supported by CAD software, to visually identify regions subject to modification.

## 3.3. POST 3D PRINTING OPERATIONS

Additive manufacturing has become a core technology in the production of components designed through generative design methodologies. These approaches leverage structural optimization algorithms and finite element analysis (FEA) to create geometrically efficient structures. However, such geometrical complexity—often yielding organic or lattice-like forms—poses significant challenges


ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

to representation using conventional technical drawings, as these forms are not easily defined through standard dimensioning techniques [19].

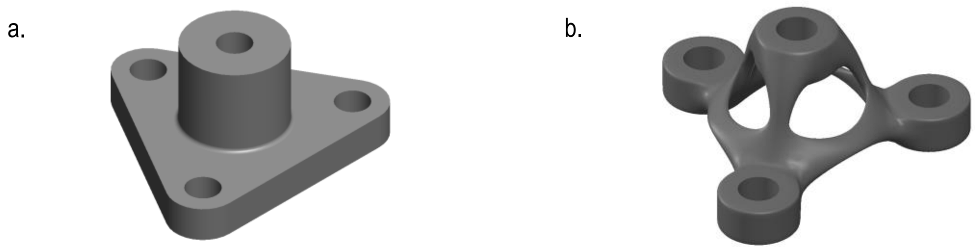



*Fig.1. Comparison between a. conventional and b. generative design approaches for an identical functional component*

Figure 1 illustrates the morphological differences between two components engineered to fulfill the same mechanical function. Subfigure 1.a represents a conventionally designed geometry, while subfigure 1.b depicts a design generated through algorithmic generative design methods, optimized for additive manufacturing.

Despite these challenges, the functionality and dimensional control of the component can be ensured through the definition of control dimensions. These are critical dimensions that guarantee proper interaction of the part with other assembly components.

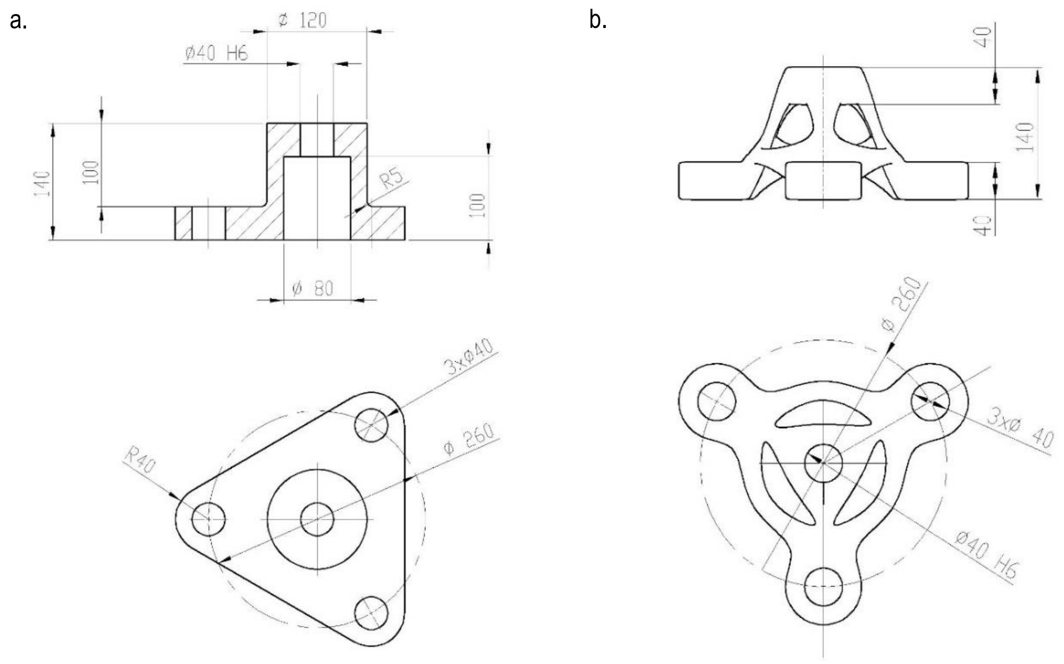



*Fig.2. Comparison between the dimensioning of a. conventional and b. generative design approaches for an identical functional component*

Figure 2 presents the dimensional specifications of both the conventional and generatively designed models. While the conventional model (Fig.2.a) allows for comprehensive dimensioning—including thicknesses, radii, and other standard geometric features—the generative design (Fig.2.b) poses significant challenges for complete dimensional annotation due to its complex geometry. As a result, functional and control dimensions become the primary means of defining the part's intended function and verifying its suitability for integration within an assembly.

### 3.3.1. Relevance of Control Dimensions in Generative Design Components


ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

Given that the overall geometry of generatively designed parts often defies traditional dimensioning, it is necessary to establish key control points for manufacturing validation [20]. Control dimensions enable:

- Functional Assurance: Ensuring the correct alignment and fit of features such as holes, supports, or contact surfaces.
- Additive Manufacturing Verification: Monitoring dimensional deviations caused by material shrinkage, layer thickness, or inconsistencies in deposition quality.
- Facilitation of Inspection and Metrology: Providing measurable and traceable parameters for post-print quality control.

Dimensioning for additive manufacturing should focus on functionally relevant features, such as: center-to-center distances between holes, minimum thicknesses of load-bearing walls, critical heights and depths for assembly fit, geometric and dimensional tolerances on mating features.

### 3.3.2. Standards Governing the Dimensioning of Generative Design Components

For the accurate representation of control dimensions, adherence to international standards in technical drawing and geometric product specification (GPS) is essential. Key applicable standards include:

- ISO 128 (Parts 1–30)
- ISO 286-1 / ISO 286-2
- ISO 1101
- ISO 2768-1 and ISO 2768-2
- ISO 16792
- ASME Y14.5

### 3.3.3. Representing Control Dimensions in Technical Drawings

To ensure clarity and functionality in technical drawings of generatively designed parts, the following practices are recommended: use of Functional Dimensions, inclusion of Geometric Tolerances, clear Measurement References, inspection Tables, integration of Product Manufacturing Information (PMI).

### 3.3.4. Application in Manufacturing and Quality Control

Once control dimensions are defined in the technical drawing, inspection of the printed component may be performed using coordinate Measuring Machines (CMMs), 3D Scanning with CAD Comparison, Manual Instruments (e.g., Micrometers and Calipers).

In summary, the precise definition of control dimensions in technical representations of 3D-printed, generatively designed components is essential to ensure the final product's accuracy and functional reliability. Applying international standards and advanced dimensioning techniques facilitates effective communication across design, manufacturing, and quality assurance teams.

## 3.4. TEST SPECIMENS

In additive manufacturing, whether in industrial applications or prototype development, ensuring the repeatability and quality of materials is fundamental. A widely accepted practice involves the fabrication of standardized test specimens [21] using the same material and parameters as the final component. Mechanical tests are conducted on these specimens to assess the properties of the material.

This approach not only confirms the mechanical behavior but also contributes significantly to material traceability, helping maintain uniformity across various production batches or printing parameters.

### 3.4.1. Mechanical Testing of Standardized Specimens in 3D Printing

Parts produced via additive manufacturing can exhibit variability in mechanical performance due to factors such as variations in material composition, build orientation and layer arrangement, affecting anisotropy and stress distribution, thermal and print speed effects, influencing microstructural development, interlayer porosity and bonding, which may impact fatigue and strength characteristics.

To validate that the manufactured component meets mechanical requirements, the following standardized mechanical tests are commonly applied to specimens: Tensile Testing (ISO 527, ASTM D638, ASTM E8), Compression Testing (ISO 604, ASTM D695),


ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

Flexural Testing (ISO 178, ASTM D790), Impact Testing (ISO 179, ASTM D256) Hardness Testing (Rockwell: ISO 6508-1, ASTM E18, Vickers: ISO 6507, ASTM E92), Fatigue Testing (ISO 1099, ASTM E466).

### 3.4.2. Material Traceability in Additive Manufacturing

Producing a test specimen per material batch ensures traceability and quality control, especially with variable or recycled materials. Recommended protocols include testing each batch or print session to verify mechanical properties, assess consistency, and identify deviations. Results inform batch validation, parameter adjustments, or rejection if tolerances are not met.
Including standardized test specimens in technical documentation ensures material quality and production consistency.

## 4. REFERENCED STANDARDS

The accurate representation of technical drawings intended for additive manufacturing requires the application of current international standards that ensure a clear, precise, and standardized interpretation of technical documentation. These standards define the general principles for graphical representation, dimensioning, tolerancing and symbology that enable effective communication among designers, manufacturing engineers, and production personnel.
To establish the criteria used in this study, the following reference standards have been applied:

- General Standards for Technical Representation: ISO 128-1:2020 and ISO 5456:1996.
- Standards on Dimensioning and Tolerancing: ISO 129-1:2018; ISO 6403:1993; ISO 1101:2017; ISO 10579:2010.
- Standards on Symbology and Lettering in Technical Drawings: ISO 3098-2:2000; ISO 5455:1979; ISO 7200:2004.
- Standards Specific to Technical Documentation in the Aerospace Sector: UNE-EN 4408-001:2005; UNE-EN 4408-006:200.
- Relevance of Standardization in Technical Drawings for Additive Manufacturing. Adhering to these standards is essential for the proper interpretation of technical drawings, particularly in the context of additive manufacturing.

ISO 128-1 and ISO 129-1 establish core principles for line representation and dimensioning in technical drawings. ISO 1101 and ISO 10579 define how to specify dimensional and geometrical features of 3D-printed parts. ISO 6403 addresses threaded elements, including guidance on thread inserts. ISO 5456 sets projection methods for converting 3D models into 2D views, while ISO 7200 standardizes title blocks and information tables to ensure document traceability and management.
The application of these normative frameworks facilitates the standardization of technical drawings for additive manufacturing, enhancing their interoperability across diverse industrial sectors and ensures that components designed and fabricated under these guidelines are compatible with conventional production processes.

## 5. REPRESENTATION OF PRINTING PARAMETERS AND TECHNICAL SPECIFICATIONS IN ENGINEERING DRAWINGS

### 5.1. DRAWING CONTENT

The technical documentation associated with additive manufacturing must adhere to the principles of clarity, precision, and standardization, in accordance with ISO 128, which governs the general principles of representation in technical drawings. To ensure accurate interpretation by production technicians and operators, the drawing must incorporate the following key sections:

- Print Parameter List: This section shall specify the manufacturing conditions crucial for ensuring reproducibility and functional performance.
- Seam Position Definition: In Fused Deposition Modeling (FDM) technology indicates where each layer starts and ends, helping to reduce surface defects and manage residual stresses.
- Indication of Non-Perimeter Faces (if applicable): Highlights surfaces without outer walls, exposing internal infill for functional reasons like weight reduction or permeability, and must be clearly marked for quality assurance and design verifications (Fig.S5).
- Post-Processing Features (if applicable): Some 3D-printed components require secondary machining operations—such as drilling, threading, or grinding—to meet functional or dimensional requirements.

It is important to note that the geometry represented in the drawing corresponds to the pre-machining state, prior to any post-processing that could alter dimensions or surface properties.

### 5.2. GENERAL TOLERANCES


UK Zhende Publishing Limited
Unit 1804 South Bank Tower, 55 Upper Ground - London (UK) SE1 9EY
Phone +86 13851794319 – www.revistadyna.com - email: dyna@revistadyna.com
ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

Geometrical tolerances must be defined in accordance with international standards to ensure compatibility with other manufacturing and quality control processes. Unless otherwise specified, the following standards shall apply:

- ISO 129-1:2018
- ISO 1101:2017

When specific tolerances are required for individual features, these shall be explicitly indicated using standardized symbols as per ISO 10579 for non-dimensioned features or ISO 129-1 for dimensional tolerances.

## 5.3. LINE TYPES

The line types employed in technical drawings for additive manufacturing shall conform to ISO 128, which defines the standard graphical conventions for technical documentation. The line types utilized in this context include:

- Seam Line: Represented by a long-dashed dotted line according to ISO 128, indicating the location of layer seam formation in FDM printing. Its accurate placement is crucial for avoiding aesthetic defects and mitigating localized stress concentrations.
- Surface Finishing Line: Defined in accordance with ISO 1302, this line is used to indicate required surface treatments or post-processing operations following the additive manufacturing process.

## 5.4. SYMBOLS

In the context of additive manufacturing, the graphical specification of geometric and manufacturing features is essential for accurate fabrication. These symbols must be associated with specific geometric entities such as faces, edges, or vertices of the part. Their primary function is to precisely communicate the requirements of the additive process to the operator or automated system.

- Coordinate System (Fig. 3.a): The coordinate system symbol defines the spatial orientation of the component within the build volume. It establishes both the positioning on the print bed and the directionality of nozzle movement. The Cartesian axes must be labeled as illustrated in Figure 3.b.
- Print Path Orientation (Fig. 3.c): The print path (bead) is a visible surface feature whose orientation may be critical for aesthetic or functional reasons. The representative symbol shall indicate this orientation on the drawing. For non-vertical paths, a dashed line may accompany the symbol to illustrate its trajectory. If the bead follows a strictly vertical path (bottom to top), the additional line is optional.
- Open/Non-Perimeter Wall (Fig. 3.d): Certain geometries may exclude solid perimeter generation for specific faces due to structural, functional, or aesthetic reasons. These faces must be explicitly marked on the drawing to permit internal infill visibility. The relevant symbol must be placed clearly on the corresponding face.

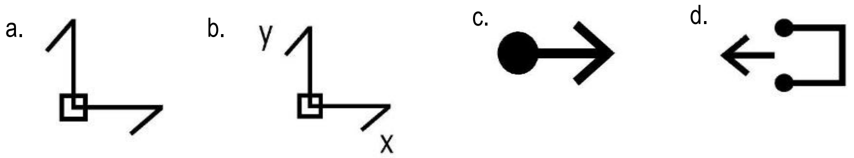



*Fig.3.a. Symbol representing the coordinate system, b. Coordinate system symbol with spatial reference axes indicated, c. Symbol indicating the orientation of the extrusion bead (print path) d. Symbol representing a wall without perimeter*

Figure 4 presents a representative example of how the above symbols should be inserted and positioned in a technical drawing of a typical component.


ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

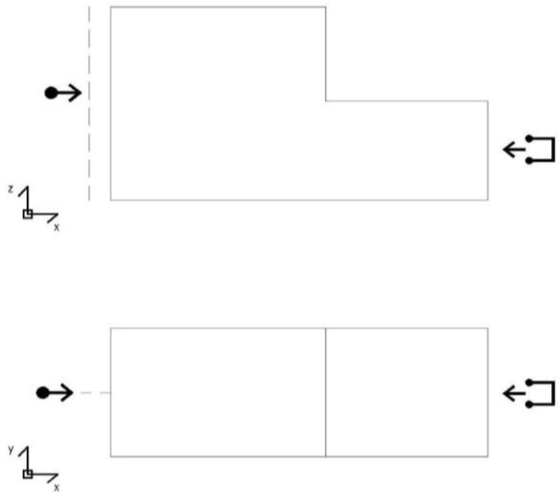


*Fig.4. Example illustrating the correct insertion and positioning of the various additive manufacturing-specific symbols within a technical drawing*

## 5.5. SYMBOL DIMENSIONS

To ensure readability and proper interpretation, all graphical symbols and associated annotations must comply with ISO 3098-2, which governs technical lettering standards. Recommended symbol dimensions are illustrated in Figure 5, and their values—based on drawing sheet size—are summarized in Table 1.

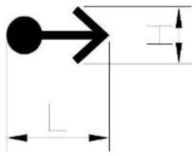



*Fig.5. Dimensional specification of a symbol*

| Dimensions | Format | |
|---|---|---|
| | A4, A3, A2 [mm] | A1, A0 [mm] |
| Line Thickness | 0,5 | 0,7 |
| L | 5 | 7 |
| H | 3 | 5 |

*Table 1. Recommended symbol dimensions based on drawing format size*

The proportions of each symbol must be scaled relative to the drawing format to maintain clarity and prevent overlap with other graphical elements.

## 5.6. LIST OF PARAMETERS

The specification of printing parameters must be integrated into the technical drawing using a standardized table format, as shown in Figure 6. This table shall contain key parameters governing the additive manufacturing process, including layer height, print speed, extrusion temperature, among others (as a result of defining these parameters, the outcomes observed on the printed part are shown in Figures S6, S7, and S8). These values must be presented in compliance with current standards in technical graphical representation.


ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

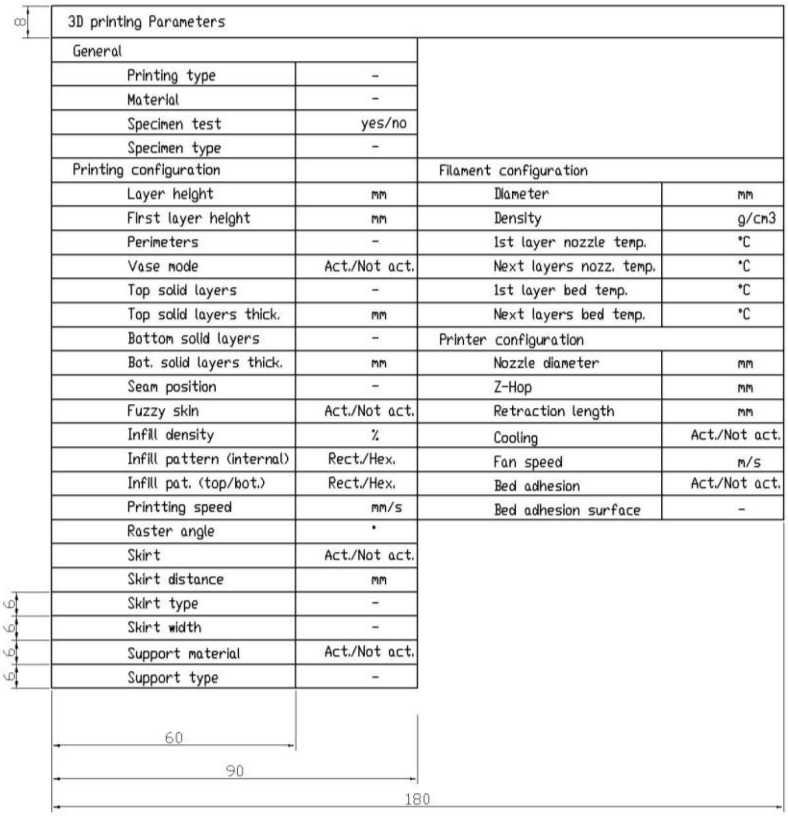



*Fig.6. Standardized table layout for the specification of 3D printing process parameters*

## 6. CONCLUSIONS

This study proposes a standardized and adaptable framework for incorporating essential 3D printing parameters into technical drawings, with the aim of enhancing communication and traceability throughout the additive manufacturing (AM) workflow. Rather than evaluating the mechanical or functional impact of specific parameters, the article emphasizes the importance of formally representing such parameters—such as layer height, infill, or extrusion temperature—within CAD-based technical documentation. These parameters are not fixed and may vary depending on the AM technology used; therefore, the proposed framework is designed to be flexible, allowing for the inclusion or omission of parameters as needed. By aligning with established drawing standards such as ISO 7200 and ISO 129, this approach reinforces the role of 2D technical drawings as a valid and necessary tool for design verification, documentation, and manufacturing consistency in AM environments.

## SUPPLEMENTARY INFORMATION

This supplementary information contains figures that were left out of the article for the sake of conciseness. This information supports the “Terms and Parameters definition” and “Representation of Printing Parameters and Technical Specifications in Engineering Drawings” sections.

Figure S1 shows two seam positions aligned with different perimeter layer configuration



ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

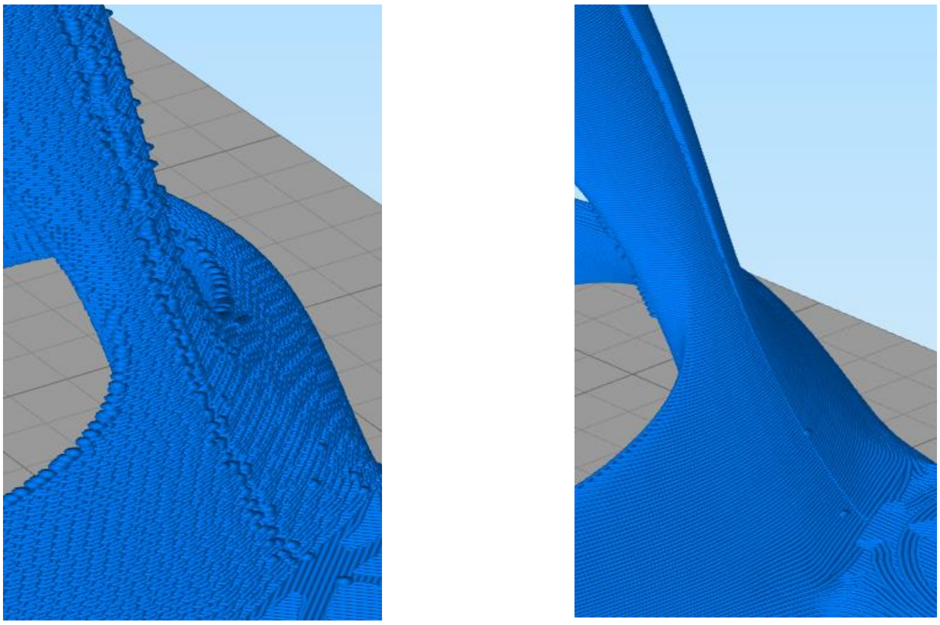


*Fig.S1. 3D printed part fabricated with seam position aligned a. with no perimeter and b. with perimeter layers*

Figure S2 a and b shows two different infill densities used to print the same part.

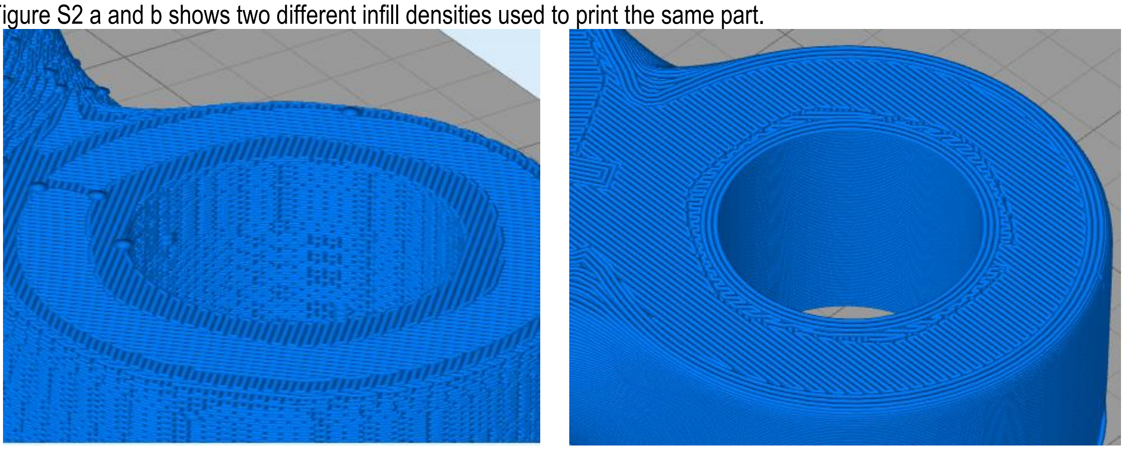
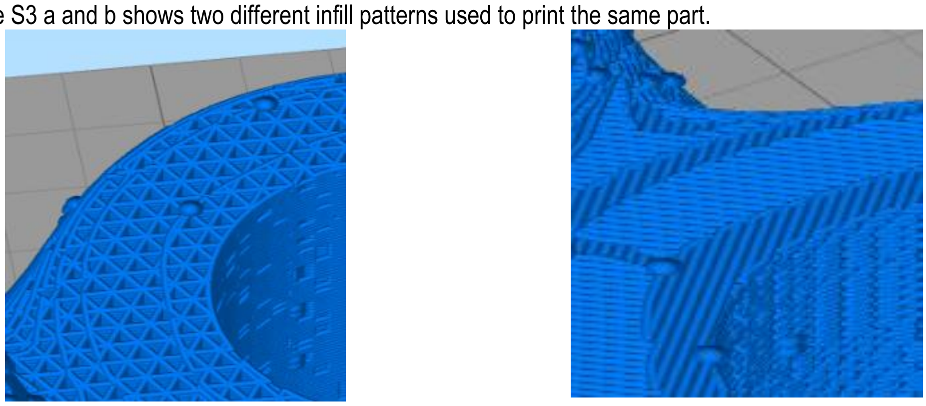


*Fig.S2. 3D printed part fabricated with a. 80% infill density and b. 100% infill density*

Figure S3 a and b shows two different infill patterns used to print the same part.




ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

*Fig.S3. 3D printed part fabricated with a. triangular and b. rectilinear (0/90°) infill pattern*

Figure S4 shows a 3D printed part fabricated with a pre-print perimeter line in contact with the bed.

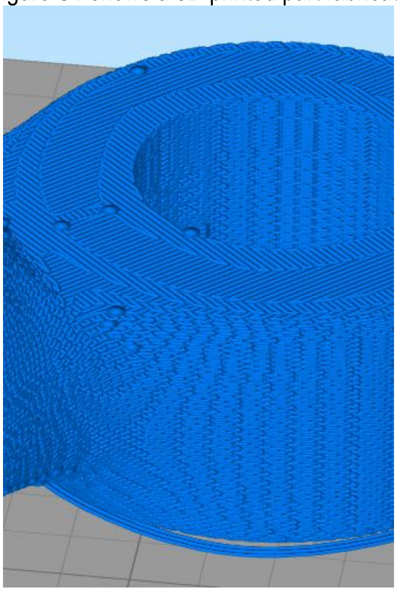


*Fig.S4. 3D printed part fabricated with skirt enabled*

Figure S5 shows the difference between printing with and without perimeter layers

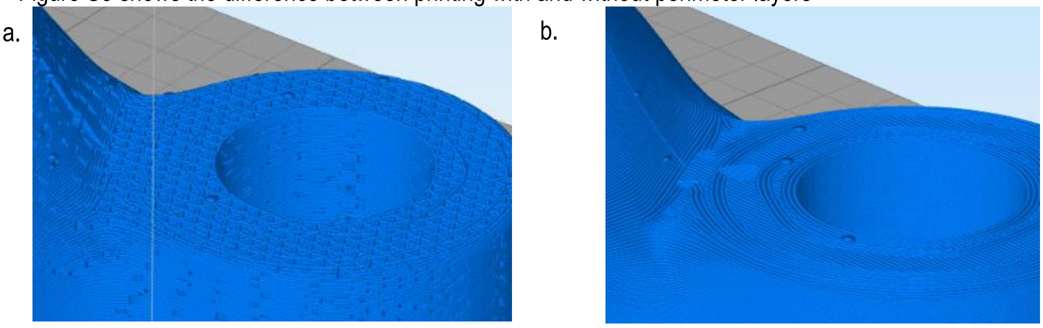



*Fig.S5. 3D printer part a. without and b. with perimeter layers applied to the geometry*

Figure S6 presents two different configurations of support type parameter

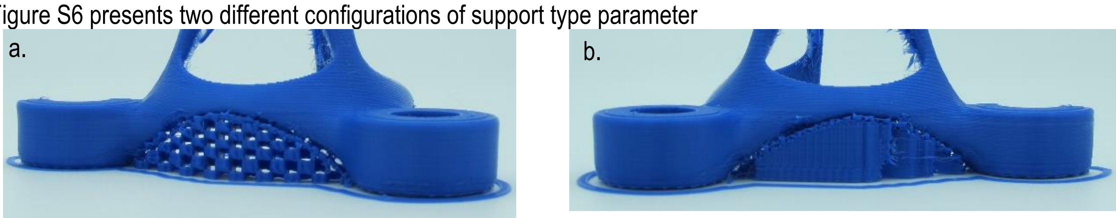



*Fig.S6. a. Alternate construction support type and b. continuous vertical construction support type*

Figure S7 presents the skirt parameter activated and the central support type configuration


ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

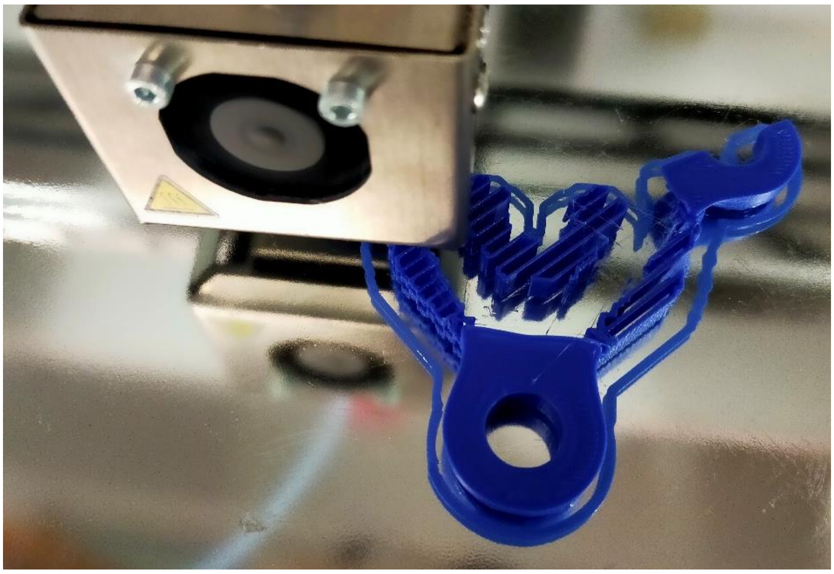


*Fig.S7. Stage of 3D printing of the part including the central support and the skirt*

Figure S8 presents the outcome obtained upon defining all the parameters listed in the table of Figure 6

*Fig.S8. Final 3D printed part*

## REFERENCES

[1] CAMPBELL, Thomas, Christopher WILLIAMS, Olga IVANOVA a Banning GARRETT. Could 3D printing change the world. *Technologies, Potential, and Implications of Additive Manufacturing, Atlantic Council, Washington, DC*. 2011, **3**(1), 18.
[2] JANDYAL, Anketa, Ikshita CHATURVEDI, Ishika WAZIR, Ankush RAINA a Mir Irfan UL HAQ. 3D printing – A review of processes, materials and applications in industry 4.0. *Sustainable Operations and Computers* [online]. 2022, **3**, 33–42. ISSN 26664127. Dostupné z: doi:10.1016/j.susoc.2021.09.004
[3] AL KHAWAJA, Huda, Haleimah ALABDOULI, Hend ALQAYDI, Aya MANSOUR, Waleed AHMED a Hamad AL JASSMI. Investigating the Mechanical Properties of 3D Printed Components. In: *2020 Advances in Science and Engineering Technology International Conferences (ASET)*: *2020 Advances in Science and Engineering Technology International Conferences (ASET)* [online]. Dubai, United Arab Emirates: IEEE, 2020, s. 1–7 [vid. 2025-10-07]. ISBN 978-1-72814-640-9. Dostupné z: doi:10.1109/ASET48392.2020.9118307
[4] NAVEED, Nida a Muhammad Naveed ANWAR. Optimising 3D printing parameters through experimental techniques and ANOVA-BASED statistical analysis. *SPE Polymers* [online]. 2024, **5**(2), 228–240. ISSN 2690-3857, 2690-3857. Dostupné z: doi:10.1002/pls2.10122

[5] SIMION, Ionel a Aurel Florin ARION. Dimensioning rules for 3D printed parts using additive technologies (FDM). *University Politechnica of Bucharest Scientific Bulletin, Series D*. 2016, **78**(2), 79–92.
[6] BANJANIN, Bojan, Magdolna PÁL, Vladimir DIMOVSKI, S ADAMOVIC a A LILIC. 3D printing in the education of graphic engineering and design students. In: *10th international symposium on graphic engineering and design*. 2020, s. 457–468.
[7] BALLETTI, Caterina, Martina BALLARIN a Francesco GUERRA. 3D printing: State of the art and future perspectives. *Journal of Cultural Heritage* [online]. 2017, **26**, 172–182. ISSN 12962074. Dostupné z: doi:10.1016/j.culher.2017.02.010
[8] KHAN, Saifuddin, Ketan JOSHI a Samadhan DESHMUKH. A comprehensive review on effect of printing parameters on mechanical properties of FDM printed parts. *Materials Today: Proceedings* [online]. 2022, **50**, 2119–2127. ISSN 22147853. Dostupné z: doi:10.1016/j.matpr.2021.09.433
[9] MANOJ PRABHAKAR, M., A.K. SARAVANAN, A. HAITER LENIN, I. JERIN LENO, K. MAYANDI a P. SETHU RAMALINGAM. A short review on 3D printing methods, process parameters and materials. *Materials Today: Proceedings* [online]. 2021, **45**, 6108–6114. ISSN 22147853. Dostupné z: doi:10.1016/j.matpr.2020.10.225
[10] GIRI, Jayant, Anagha CHIWANDE, Yash GUPTA, Chetan MAHATME a Pallavi GIRI. Effect of process parameters on mechanical properties of 3d printed samples using FDM process. *Materials Today: Proceedings* [online]. 2021, **47**, 5856–5861. ISSN 22147853. Dostupné z: doi:10.1016/j.matpr.2021.04.283
[11] AMETA, Gaurav, Robert LIPMAN, Shawn MOYLAN a Paul WITHERELL. Investigating the Role of Geometric Dimensioning and Tolerancing in Additive Manufacturing. *Journal of Mechanical Design* [online]. 2015, **137**(11), 111401. ISSN 1050-0472, 1528-9001. Dostupné z: doi:10.1115/1.4031296
[12] LEITE, Marco, João FERNANDES, Augusto M DEUS, Luis REIS a Maria Fátima VAZ. Study of the influence of 3D printing parameters on the mechanical properties of PLA. 2018.
[13] ESPINO, Michaela T., Brian J. TUAZON, Alejandro H. ESPERA, Carla Joyce C. NOCHESEDA, Roland S. MANALANG, John Ryan C. DIZON a Rigoberto C. ADVINCULA. Statistical methods for design and testing of 3D-printed polymers. *MRS Communications* [online]. 2023, **13**(2), 193–211. ISSN 2159-6867. Dostupné z: doi:10.1557/s43579-023-00332-7
[14] SHAHRUBUDIN, N., T.C. LEE a R. RAMLAN. An Overview on 3D Printing Technology: Technological, Materials, and Applications. *Procedia Manufacturing* [online]. 2019, **35**, 1286–1296. ISSN 23519789. Dostupné z: doi:10.1016/j.promfg.2019.06.089
[15] DOSHI, Manav, Ameya MAHALE, Suraj KUMAR SINGH a Samadhan DESHMUKH. Printing parameters and materials affecting mechanical properties of FDM-3D printed Parts: Perspective and prospects. *Materials Today: Proceedings* [online]. 2022, **50**, 2269–2275. ISSN 22147853. Dostupné z: doi:10.1016/j.matpr.2021.10.003
[16] HAMAT, S., M.R. ISHAK, S.M. SAPUAN, N. YIDRIS, M.S. HUSSIN a M.S. ABD MANAN. Influence of filament fabrication parameter on tensile strength and filament size of 3D printing PLA-3D850. *Materials Today: Proceedings* [online]. 2023, **74**, 457–461. ISSN 22147853. Dostupné z: doi:10.1016/j.matpr.2022.11.145
[17] STABILE, L., M. SCUNGIO, G. BUONANNO, F. ARPINO a G. FICCO. Airborne particle emission of a commercial 3D printer: the effect of filament material and printing temperature. *Indoor Air* [online]. 2017, **27**(2), 398–408. ISSN 09056947. Dostupné z: doi:10.1111/ina.12310
[18] SHAH, J., B. SNIDER, T. CLARKE, S. KOZUTSKY, M. LACKI a A. HOSSEINI. Large-scale 3D printers for additive manufacturing: design considerations and challenges. *The International Journal of Advanced Manufacturing Technology* [online]. 2019, **104**(9–12), 3679–3693. ISSN 0268-3768, 1433-3015. Dostupné z: doi:10.1007/s00170-019-04074-6
[19] OROPALLO, William a Les A. PIEGL. Ten challenges in 3D printing. *Engineering with Computers* [online]. 2016, **32**(1), 135–148. ISSN 0177-0667, 1435-5663. Dostupné z: doi:10.1007/s00366-015-0407-0
[20] PEI, Eujin, Israt KABIR, Tomislav BREŠKI, Damir GODEC a Axel NORDIN. A review of geometric dimensioning and tolerancing (GD&T) of additive manufacturing and powder bed fusion lattices. *Progress in Additive Manufacturing* [online]. 2022, **7**(6), 1297–1305. ISSN 2363-9512, 2363-9520. Dostupné z: doi:10.1007/s40964-022-00304-8
[21] ĆWIKŁA, Grzegorz, Cezary GRABOWIK, Krzysztof KALINOWSKI, Iwona PAPROCKA a Piotr OCIEPKA. The influence of printing parameters on selected mechanical properties of FDM/FFF 3D-printed parts. In: *IOP conference series: materials science and engineering*. B.m.: IOP Publishing, 2017, s. 012033. ISBN 1757-899X.