JTC 1 3D Printing and Scanning WG

Byoung Nam Lee
ETRI

Table of Contents

JTC 1 Working Group on 3D Printing and Scanning

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Resolution 11 – Establishment of JTC 1/WG 12 on 3D Printing and Scanning

(JTC 1 Plenary, October 2017 in Vladivostok, Russia)

Contingent upon approval of a relevant NWIP, JTC 1 establishes JTC 1 Working Group 12 on 3D Printing and Scanning with the following Terms of Reference:

1. Serve as a focus of and proponent for JTC 1's standardization program on 3D Printing and Scanning.
2. Develop ICT related foundational standards for 3D Printing and Scanning upon which other standards can be developed.
3. Develop other 3D Printing and Scanning standards that are built upon the foundational standards when relevant ISO and IEC committees that could address these standards do not exist or are unable to develop them.
4. Identify gaps and opportunities in 3D Printing and Scanning standardization.
5. Develop and maintain liaisons with all relevant ISO and IEC committees as well as with external organizations that have interests in 3D Printing and Scanning.

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Resolution 11 – Establishment of JTC 1/WG 12 on 3D Printing and Scanning

(JTC 1 Plenary, October 2017 in Vladivostok, Russia)

6. Engage with 3D Printing and Scanning communities to raise awareness of JTC 1 standardization efforts and provide an open platform for discussion and further cooperation.

7. Develop and maintain a list of existing 3D Printing and Scanning standards produced and standards development projects underway in ISO TCs, IEC TCs and JTC 1.

JTC 1 appoints Byoung Nam Lee to serve as Convenor of JTC 1 Working Group 12 on 3D Printing and Scanning.

To continue to progress the topic of 3D Printing and Scanning in a timely manner, the Study Group on 3D Printing and Scanning will remain in place, with Byoung Nam Lee as Convenor, pending the approval of an NWIP. Once an NWIP has been approved, the Study Group on 3D Printing and Scanning is disbanded and the JTC 1 Working Group 12 Convenor will work with ITTF to formally establish Working Group 12 within the ISO system.

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JTC 1 Study Group on 3D Printing and Scanning

Resolution 2 – JTC 1 Study Group on 3D Printing and Scanning (JTC 1 Plenary, November 2016 in Lillehammer, Norway)

JTC 1 establishes a Study Group (SG) on 3D Printing and Scanning to understand the current state of standardization and to explore a possible role for JTC 1.

The Terms of Reference are as follows:

1) Provide a description of key concepts related to 3D Printing and Scanning, and describe relevant terminology.
2) Study and document the technological, market and related societal requirements for the future ICT standardization on 3D Printing and Scanning.
3) Study and document current technologies that are being deployed to enable 3D Printing and Scanning.
4) Promote the awareness of the importance of JTC 1 activities on 3D Printing and Scanning outside JTC 1.
5) Assess the current state of standardization activities relevant to 3D Printing and Scanning within JTC 1, in other relevant ISO and IEC TCs, in other SDOs and in consortia.

Resolution 2 – JTC 1 Study Group on 3D Printing and Scanning (JTC 1 Plenary, November 2016 in Lillehammer, Norway)

6) Identify and propose how JTC 1 should address the ICT standardization needs of 3D Printing and Scanning.

7) Provide progress reports to the JAG and a report with recommendations, and potentially one or more draft NWIPs, to the 2017 JTC 1 Plenary.

Membership in the SG on 3D Printing and Scanning is open to:

1. JTC 1 National Bodies, JTC 1 Liaisons and approved JTC 1 PAS Submitters;
2. JTC 1/SCs, JTC 1/WGs, relevant ISO and IEC TCs;
3. Members of ISO and IEC central offices; and
4. Invited standards setting organizations that are engaged in 3D Printing and Scanning standardization as approved by the SG on 3D Printing and Scanning.

JTC 1 appoints Byoung Nam Lee as Convenor of the Study Group.

JTC 1 instructs its Secretariat to issue a call for participation in the Study Group.

Participants

Byoung nam Lee	Convenor
Yaeseul Park	Secretary
Gilles Thonet	IEC CO
Kei Yamashita	JTC 1/SC 23
Cong Wang	JTC 1/SC 24
Farid Mamaghani	
Don Brutzman	
Roy Walmsley	
Ha Jine Kimn	
Hwanyong Lee	
Kwan-Hee Yoo	
Hyokwang Lee	
Myeong Won Lee	
Ian Stroud	ISO TC 184/SC 1/WG 7
Jumyung Um	
Howard Mason	ISO TC 184/SC 4
Soonhung Han	
Eujin Pei	ISO TC 261
Klas Boivie	
Jörg Lenz	
François Coallier	Canada (SCC)
Haibin Li	China (SAC)
Johan Wirta	Finland (SFS)
Patrick Marchand	France (AFNOR)
Christophe Mouton	
Brian McAuliffe	Ireland (NSAI)
Satoshi Itoh	Japan (JISC)

Seung Wook Lee	Korea(Rep. of) (KATS)
Dongyub Lee	
Hongki Cha	
Hyun Jeong Kim	
Choon-Woo Kim	
Kyu-Won Shim	
Kuyeong Oh	
Ji-Man Park	
Alojz Hudobivn	Slovenia (SIST)
Jonathan Porter	UK (BSI)
Aydin Nassehi	
Paul Jeran	US (ANSI)
Christian Page	
Michelle Pangborn	
Diane Stephens	
Paul Tykodi	
Jennifer Garner	
Young Lae Moon	3D Medical Application Work Group, IEEE-SA
Adrian Lannin	3MF Consortium
Lauralyn McDaniel	America Makes & ANSI AMSC
Jérémie Farret	ASTM F42
Pat A. Picariello	ASTM F57
Allan Noordvyk	DICOM
Justin Ryan	
Vincent Marchetti	Web3D Consortium

Summary of Activities

- December 9, 2016: Issued "Call for participation in the JTC 1 Study Group (SG) on 3D Printing and Scanning"(JTC 1 N13278)
- January 27, 2017: 1st Teleconference (ISO/IEC JTC 1/SG 3 N 2)
- February 24, 2017: 2nd Teleconference (ISO/IEC JTC 1/SG 3 N 10)
- March 31, 2017: 3rd Teleconference (ISO/IEC JTC 1/SG 3 N 19)
- April 28, 2017: 4th Teleconference (ISO/IEC JTC 1/SG 3 N 24)
- May 24-26, 2017: 1st F2F Meeting in Seoul (ISO/IEC JTC 1/SG 3 N 35)
- June 30, 2017: 5th Teleconference (ISO/IEC JTC 1/SG 3 N 46)
- July 21, 2017: 6th Teleconference (ISO/IEC JTC 1/SG 3 N 61)
- August 28-September 1, 2017: 2nd F2F Meeting in Montreal (ISO/IEC JTC 1/SG 3 N 71)
- September 8, 2017: 7th Teleconference (ISO/IEC JTC 1/SG 3 N 77)

Study Group Report on 3D Printing and Scanning (JTC1 N13604)

- The purpose of this report is to assess the possible contributions of JTC 1 to the global market enabled by 3D Printing and Scanning.
- This document provides an overall review of 3D Printing and Scanning in terms of exploring IT standardization opportunities from the perspective of JTC 1.
- The JTC 1 Study Group on 3D Printing and Scanning is making this report based on these review results. Contributions of this report include:
  - An overview of 3D Printing and Scanning;
  - An analysis of active standardization activities in relevant Standards Development Organizations (SDOs) with an emphasis on information technology (IT);
  - The identification of potential standardization areas and topics relevant to JTC 1 Terms of Reference;
  - Recommendations for continued work by JTC 1.

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3D Printing and Scanning

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Key concepts

- **3D printing or Additive Manufacturing (AM)**

  Additive Manufacturing (AM) is defined as the direct production of finished goods using additive processes from digital data (EU, SASAM, 2016). It is a process of making a three-dimensional solid object of virtually any shape from a digital model. It uses an additive process, where materials are applied in successive layers.

  In contrast, subtractive manufacturing processes usually start with larger sources and successively remove unwanted materials.

- **3D scanning**

  3D scanning is an accurate and fast method which determines the shape of an entity's surface or its volume in a three-dimensional space. 3D scanners are the devices which capture 3D information about the real-world objects, thereby helping in 3D visualization and measurement.

New Paradigm Shift

- Futurologists such as Jeremy Rifkin believe that **3D printing signals the beginning of a third industrial revolution**, succeeding the production line assembly that dominated manufacturing starting in the late 19th century.

- Using the power of the Internet, **it may eventually be possible to send a blueprint of any product to any place in the world to be replicated by a 3D printer**, using "elemental inks" capable of being combined into any material substance of any desired form [1].

Comparing traditional and Additive Manufacture of a specific part

Source : SASAM Standardization in Additive Manufacturing, product diagram courtesy of COMPOLIGHT project (http://www.smartlam.eu/index.php/related-projects.html)

- AM typically eliminates the need for tooling.
- It can be created fast, flexibly, and with fewer machines.

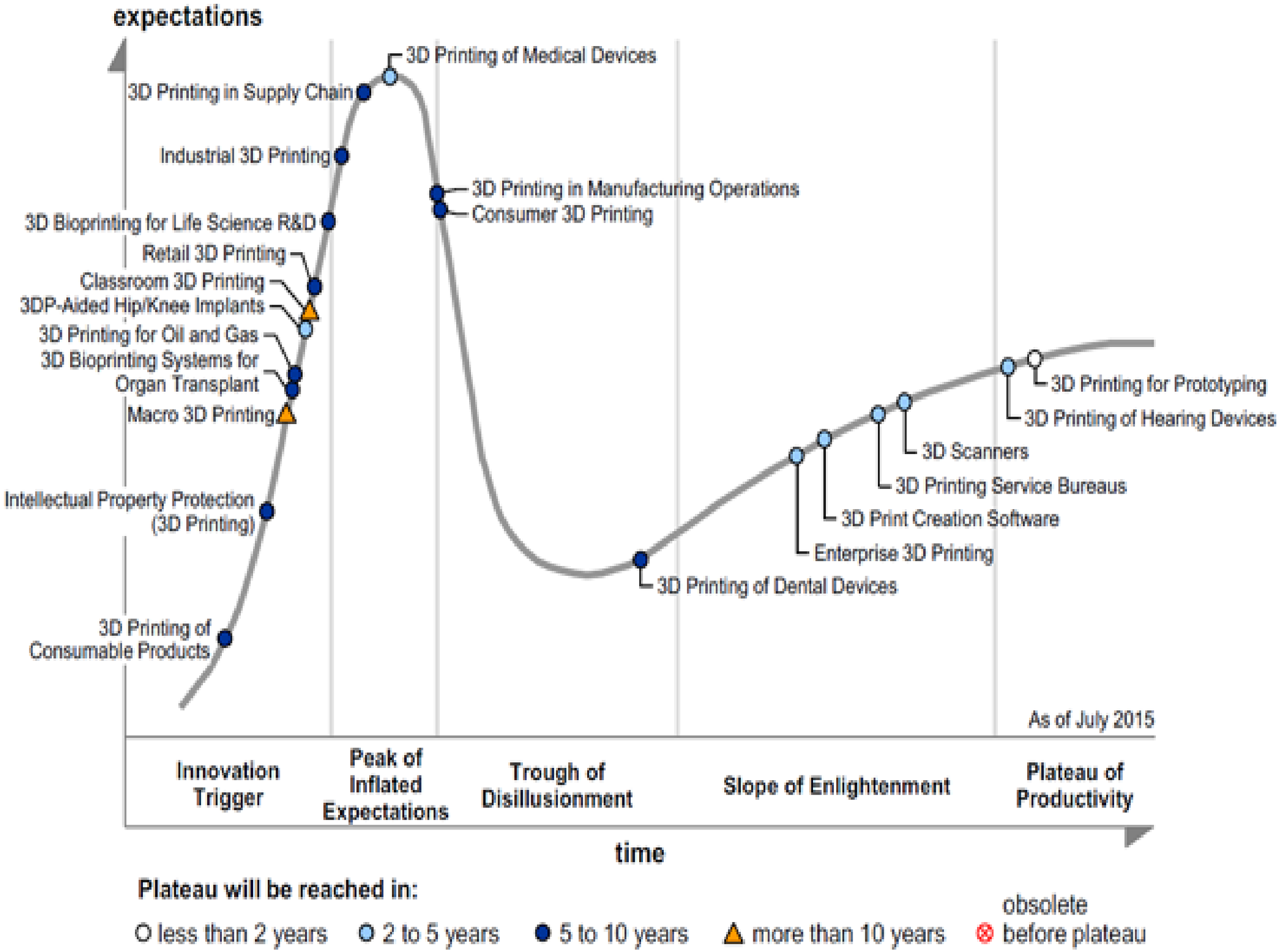
Technology

3D Printing Technologies

Type	Technologies	Materials
Extrusion	Fused deposition modeling (FDM) or Fused Filament Fabrication (FFF)	Thermoplastics, eutectic metals, edible materials, Rubbers, Modeling clay, Plasticine, Metal clay (including Precious Metal Clay)
	Robocasting or Direct Ink Writing (DIW)	Ceramic materials, Metal alloy, cermet, metal matrix composite, ceramic matrix composite
Light polymerized	Stereolithography (SLA)	Photopolymer
	Digital Light Processing (DLP)	Photopolymer
	Solid Ground Curing (SGC)	Photopolymer
	Polyjet	Photopolymer
Powder Bed	Powder bed and inkjet head 3D printing (3DP)	Almost any metal alloy, powdered polymers, Plaster
	Electron-beam melting (EBM)	Almost any metal alloy including Titanium alloys
	Selective laser melting (SLM)	Titanium alloys, Cobalt Chrome alloys, Stainless Steel, Aluminum
	Selective heat sintering (SHS)	Thermoplastic powder
	Selective laser sintering (SLS)	Thermoplastics, metal powders, ceramic powders
	Direct metal laser sintering (DMLS)	Almost any metal alloy
Laminated	Laminated object manufacturing (LOM)	Paper, metal foil, plastic film
Powder Fed	Directed Energy Deposition	Almost any metal alloy
Wire	Electron beam freeform fabrication (EBF)	Almost any metal alloy

Market

Gartner 2015 Hype Cycle for 3D printing



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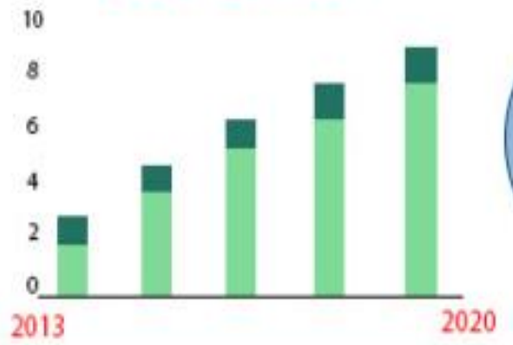
Estimation of the Global 3D Printing Market

GLOBAL 3D PRINTING MARKET

Size & Forcast,
(2013-2020)

GLOBAL 3D PRINTING MARKET

Market is Expected to Reach
$8.6 Billion by 2020



Growing At a CAGR of 20.6%. (2014-2020)

GLOBAL 3D PRINTING MARKET BY TECHNOLOGY

- Stereolithography
- Selective Laser Sintering
- Electron Beam Melting
- Fused Deposition Modeling
- Laminated Object Manufacturing
- Others

GLOBAL 3D PRINTING MARKET BY GEOGRAPHY

NORTH AMERICA, ASIA-PACIFIC ,LAMEA

EUROPE

Highest Revenue Generating Geography
$3.563 Billion by 2020

GLOBAL 3D PRINTING MARKET BY APPLICATION

Consumer Products	Industrial Products
Defense	Aerospace
Healthcare	Automotive
Education and Research	Others

GLOBAL 3D PRINTING MARKET BY MATERIAL

Polymers	Metals
Ceramics	Others

GLOBAL 3D PRINTING MARKET DYNAMICS

Drivers

- Efficient use of material
- Use of multiple materials for printing
- Reduction in human error
- Customization of products
- More competitive advantages
- Delivering various innovation opportunities
- Reduces development cost and time
- Efficient logistic management

Restraints

- Higher cost for individual user
- Software required for 3D printing are costly
- Lack of channel partner assistance
- Lack of skilled labor
- Size of output generated

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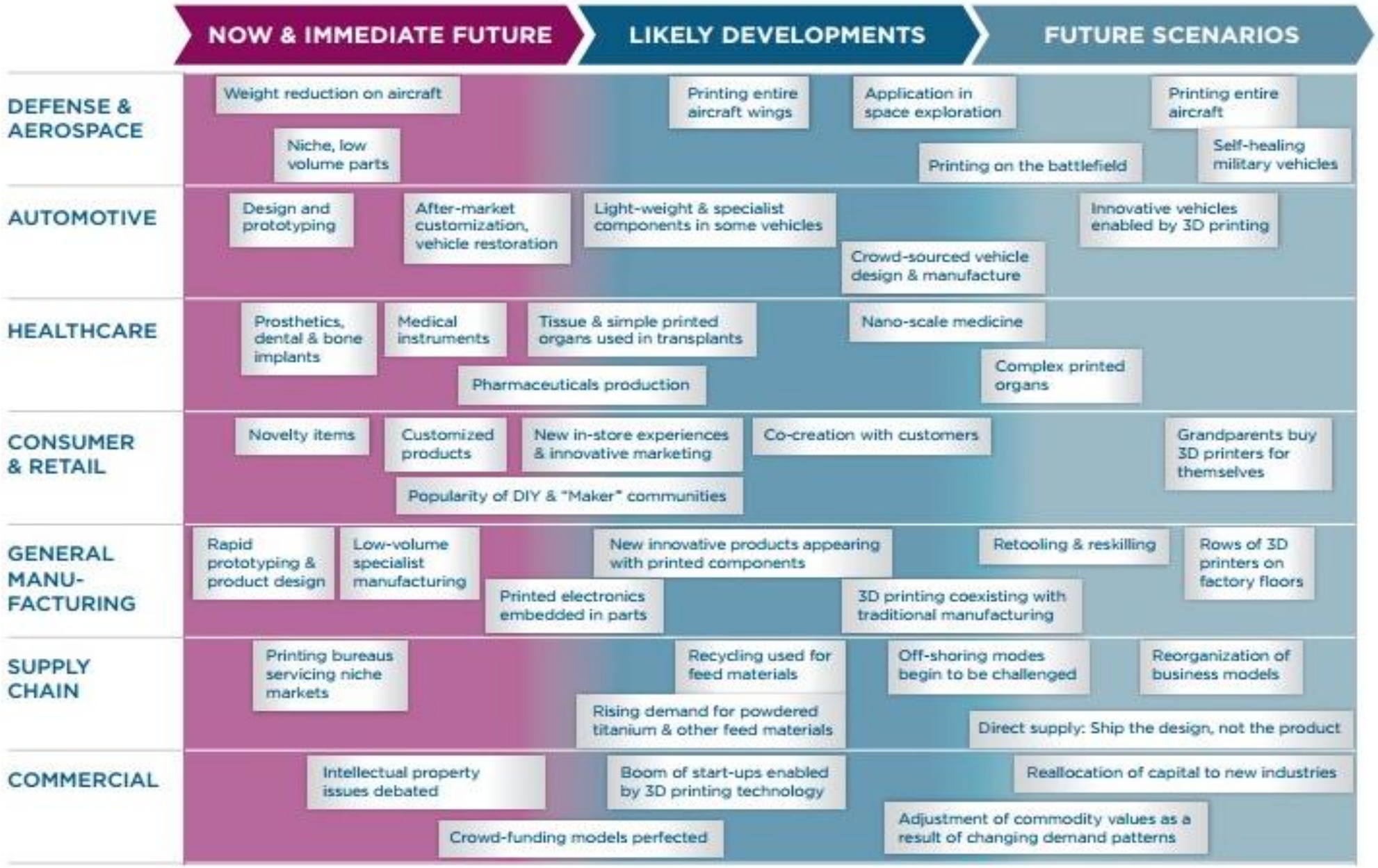
3D printing impact on various industries

FIGURE 24. 3D PRINTING IMPACTS



Source: CSC

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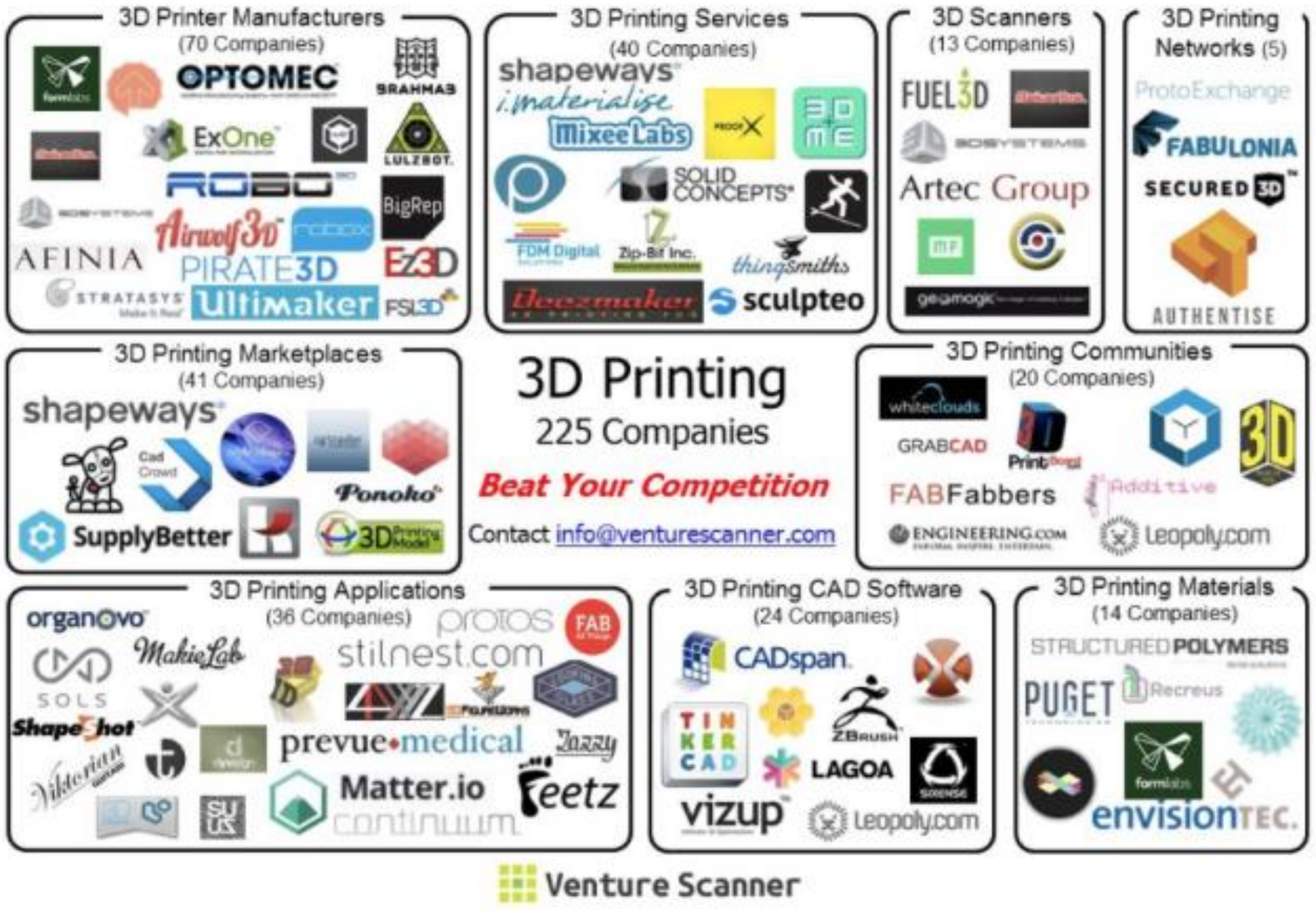
3D Scanning and Printers companies



Use Case and Standardization Requirements

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Use cases in 3D printing and scanning industry

Medical Industry	Health & Wellness	Gaming & Animation
Cranial 3D scanning and printing Dental prostheses Decease recognition (mixed) Prosthesis creation Manufacturing of surgical practice dummies	Fitness Body wellness Artificial Intelligence Healthcare	3D gaming Movie animation Personal animation and personalization
AR & VR Activities	**Manufacturing**	**Apparel & Fashion**
Leisure and business use cases	Aerospace Automobile Electronics Consumer goods	Fitting / online clothes sale Made to measure clothes Fashion design
Urbanization	**Transportation**	**Industry R&D**
Building industry City / environment planning Road and railway design and manufacturing	Land Air Sea Space	3D scanning and printing used to fasten product development cycles

JTC 1 Perspectives

- Use Cases in General Manufacturing:
  - Manufacturing for production parts
  - Manufacturing for multi-process parts
  - Mold making
  - Part repair, remanufacturing
  - Manufacturing for amateur users
  - Manufacturing archiving
  - Cloud services for additive manufacturing
- Use Cases in Medical Applications:
  - Cranial implants
  - Dental prostheses

IT standardization activities

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Relevant Standardization Activity

- **ISO TC 261 Additive manufacturing**
- ISO TC 61 (Plastics)
- ISO TC 106 (Dentistry)
- ISO TC 119 (Powder Metallurgy)
- ISO TC 171/SC 2 (Document File Format)
- ISO TC 172/SC 9 (Electro–optical Systems)
- **ISO TC 184/SC 1 (Industrial Cyber and Physical Manufacturing Systems)**
- **ISO TC 184/SC 4 (Industrial Data)**
- **IEC TC 62 (Electrical Equipment in Medical Practice)**
- **IEC TC 76 (Optical Radiation Safety and Laser Equipment)**
- **IEC TC 108 (Safety of Electronic Equipment within the Field of Audio/Video, Information Technology and Communication Technology)**
- **IEC TC 119 (Printed Electronics)**
- **IEEE-ISTO Printer Working Group (PWG)**
- IEEE C3DP (Consumer 3D Printing Working Group)

Relevant Standardization Activity

- IEEE 3DMA (3D Based Medical Application Working Group)
- **ASTM Committee F42 on Additive Manufacturing Technologies**
- **ASTM Committee E57 on 3D Imaging Systems**
- **3MF Consortium**
- DICOM (Digital Imaging and Communications in Medicine)
- Khronos 3D Format Working Group
- CIE (International Commission on Illumination) Division 8 (Image Technology)
- **Web3D Consortium**
- **JTC 1/SC 24**
- **JTC 1/SC 28**
- **JTC 1/SC 29/WG 11**
- **AMSC (Additive Manufacturing Standardization Collaborative)**

Gap Analysis and Identification of Opportunities

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JTC 1 Perspectives

- The survey of standardization activities has shown that:
  - Most activities are focused on the industrial market
  - Most activities are focused on material and industrial processes
  - Additional activities continue to gain broad interest
  - Coordination and cooperation with various stakeholders are needed
- There appears to be opportunities for JTC 1 to work on the following:
  - Harmonization of 3D file formats to describe 3D objects in a form suitable for printing and 3D print files, coordinated with ISO TC 261 and ISO TC 184
  - 3D file standardization through fast track of work done by industrial consortia
  - Standardization to support a consumer 3D printing market

JTC 1 Perspectives

- Industry and suppliers have difficulty knowing how to apply the standards, even though they would provide significant advantages. There is a problem of information overload where there is too much information of a general nature for people to find out what they need to know.
- Some possible gaps are:

1. Single point of reference for user community to find out information about 3D printing and scanning implementation
2. Coordination of aims within standardization activities
3. Information collection point for contact between user community and standardization bodies
4. Knowledge of how and where to apply standards
5. Possibility to evaluate standards in different circumstances
6. Links to education and professional bodies to further lifelong learning

JTC 1 Perspectives

- Some general opportunities provided are:
  1. Increased use of standards in manufacturing
  2. Lower production costs because of greater efficiency
  3. Improved support for complex tasks
  4. Increased flexibility for localized and distributed production, including via print service bureaus
  5. New technical solutions because of greater understanding and ease of use of systems
- There are currently no standard best practices for creation of protocols and validation procedures to ensure that medical imaging data can be consistently and accurately transformed into a 3D printed object.

Conclusions and Recommendations

Conclusions

- This report provided an overview of ICT related standardization opportunities in the field of 3D Printing and Scanning. Based on an in-depth analysis of ongoing technology and market developments, together with the description of several use cases and the assessment of the current standardization landscape, SG 3 identified gaps and opportunities that could be adequately addressed by JTC 1.
- Because 3D Printing and Scanning covers a very wide range of potential application domains and involves a diverse set of technologies and ICT protocols, there is a strong need for cooperation and coordination between different standards development entities, whether part of ISO, IEC or external organizations.

“Recommendation to JTC 1”

- Following its systems integration focus and its experience in collaborating with a broad set of stakeholders and organizations, JTC 1 is in a unique position to fulfil this role. There was a clear consensus among SG 3 members that JTC 1 should become the driving force for the development and promotion of foundational ICT standards related to 3D Printing and Scanning
- As two New Work Item Proposals are being put forward as part of this report, SG 3 recommends the creation of a Working Group to progress this work and to address the gaps and opportunities in 3D Printing and Scanning standardization.

Proposed Terms of Reference for a JTC 1 Working Group

1. Serve as a focus of and proponent for JTC 1's standardization program on 3D Printing and Scanning.
2. Develop ICT related foundational standards for 3D Printing and Scanning upon which other standards can be developed.
3. Develop other 3D Printing and Scanning standards that are built upon the foundational standards when relevant ISO and IEC committees that could address these standards do not exist or are unable to develop them.
4. Identify gaps and opportunities in 3D Printing and Scanning standardization.
5. Develop and maintain liaisons with all relevant ISO and IEC committees as well as with external organizations that already have or may propose work related to 3D Printing and Scanning.
6. Engage with 3D Printing and Scanning communities to raise awareness of JTC 1 standardization efforts and provide an open platform for discussion and further cooperation.

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Draft NWIP(s)

1. Information technology — Framework for Additive Manufacturing Service Platform (AMSP)

Scope

This international standard specifies the framework for Additive Manufacturing Service Platform (AMSP). The framework supports the requirements and functionalities of AMSP. This international standard also provides an overview of basic service models that AMSP could offer and describes some typical use cases.

This standard is applicable when individuals or organizations (e.g. commercial enterprises, government agencies, and non-profit organizations) build an AMSP or improve existing ones to provide printing and relevant services.

Purpose and justification of the proposal

This standard was developed in response to the needs of mass customization of additive manufacturing technology by taking full advantage of information and communication technology (ICT).

Additive Manufacturing Service Platform (AMSP) provides a website or app where users, designers, and manufacturing centres could have connections based on their own needs. With the help of an AMSP, customers could purchase specific AM objects/parts and relevant services as they required rather than AM equipment and feedstock, and do not have to have skilled staffs professionalized in AM either. There could be no up-front costs or investments when turning to AMSP.

Draft NWIP(s)

2. Information Technology— Requirements of Image Processing for covering cranial defect

Scope

This standard covers the medical image processing for covering cranial defects. Implants manufactured by Additive Manufacturing (AM) require medical-specific data and medical image data acquisition processing in order to distinguish the skull defects from the healthy parts. A standardized approach is needed to produce an accurate and consistent solid medical model based on real human image information from the use of Computed Tomography (CT) devices.

Purpose and justification of the proposal

Overall, the world revenue from Additive Manufacturing (AM) in the healthcare industry is expected to grow exponentially, yet very few guides exist for Medical Additive Manufacturing (MAM) processes. Medical Images from the human body are different from solid objects due to the non-geometric nature of the human body. To perform Medical Additive Manufacturing (MAM), an accurate and consistent approach for image processing and data creation from human images is needed. Standardization for MAM processes is urgently required for education, diagnosis, neurosurgical treatment, developing simulation models, medical equipment (including surgical guides) and surgical implantable devices in the clinical fields. FDAs from several countries (USA, Korea, etc) have already published their own guidelines for approval. However, those guidelines are not specifically designed for Additive Manufacturing.

Thank You

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