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Competition for additive manufacturing competition

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Contents

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Competition for additive manufacture competition

1 Scope

This document specifies the basic requirements, safety regulations, assessment proportion, competition result evaluation and award setting of additive manufacturing skill contest, including but not limited to the resource requirements for personnel, site and equipment of additive manufacturing skill contest.
This document is applicable to the holding and organization of additive manufacturing skill contest.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.
3.1
additive manufacturing;AM
process of joining materials to make parts from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing and formative manufacturing methodologies.
3.2
AM machine
section of the additive manufacturing system including hardware, machine control software, required set-up software and peripheral accessories necessary to complete a build cycle for producing parts.
3.3
fused deposition modeling;FDM
additive manufacturing process in which material is selectively dispensed through a nozzle or orifice.
3.4
vat photopolymerisation
additive manufacturing process in which liquid photopolymer in a vat is selectively cured by light-activated polymerization.
3.5
powder bed fusion
additive manufacturing process in which thermal energy selectively fuses regions of a powder bed.

4 Competition overview

4.1 Name

Additive manufacturing.

4.2 Name of occupation

The code and name of the occupation name (type of work) involved in the competition are 6-20-99-00 Additive Manufacturing Equipment Operator, and the national occupational skill standard level is above Level III in the Code of Occupational Classification of the People's Republic of China (Version 2022).

4.3 Purpose

In accordance with the National Vocational Skills Standards for Additive Manufacturing Equipment Operators, and in response to the national economic development's demand for highly skilled talent, this program addresses the common needs of BRICS countries in manufacturing upgrades and cross-border trade (such as low-cost innovative design, application of green manufacturing technologies, and

multilingual technical documentation collaboration). It aims to cultivate highly skilled industrial design professionals capable of collaborating internationally.

5 Basic requirements

5.1 General world skills standards specification (WSSS) requirements

This specification specifies the basic knowledge, understanding, and specific skills required for additive manufacturing technology and professions to achieve the best level of technical and professional work practice, reflecting an understanding of the work and positions in the industry.
The skills competition aims to reflect the best international practices described in this standard specification, in order to enable its implementation. Therefore, this standard serves as a guide for the training and preparation required for skills competitions.
In the skills competition, knowledge and understanding of additive manufacturing technology skills will be evaluated based on the actual skill performance of the contestants and their professional level will be determined. Standard specifications are clearly divided into several parts defined by titles and reference numbers. Each section will be assigned a certain percentage of scores to indicate its importance in the skill standard specifications. The sum of all score ratios is 100.
The scoring scheme and competition items only evaluate the skills specified in this skill standard specification. They will reflect the requirements of skill standards and specifications as fully as possible under the prescribed conditions of the skills competition, as shown in table 1.

Table 1 WSSS requirements

NO.	Skill Module	Knowledge Requirement	Skill Requirement	Percentage
1	3D scan related terms and symbols	Current health and safety regulations related to the additive manufacturing industry Use and maintain personal protective equipment and clothing Recommendations and information published by the supplier or manufacturer of the product and equipment Procedures for maintenance and use of specialied equipment Terms and symbols related to additive manufacturing Terms and symbols related to3D scanning	Be able to apply occupational health and safety regulations to the additive manufacturing industry Be able to use and maintain personal protective clothing and equipment Capable of setting, using, adjusting and maintaining all professional equipment Promote safe and healthy operations in the workplace Capable of applying recommendations and information published by product and equipment suppliers or manufacturers Compliance with manufacturer's safety instructions	5%
2	Product 3D data acquisition and reverse modeling	Operating principle of 3D scanning equipment Strengths and weaknesses of various types of 3D scanning equipment and their basic technologies The technical characteristics of the equipment for the accuracy and speed of optical 3D scanning, as well as the requirements for ensuring the feasibility of the work and the declared accuracy The importance of equipment calibration and the requirements for calibration and digitization conditions	Capable of developing sample scanning and reverse modeling strategies Be able to adjust and calibrate the scanning equipment Capable of developing scanning plans based on the characteristics of the scanned parts Capable of performing pretreatment work according to scanning scheme (disassembly, cleaning, matt coating, etc.) Optical marking according to scanning scheme Data acquisition with scanning equipment	

Table 1 (*continued*)

NO.	Skill Module	Knowledge Requirement	Skill Requirement	Percentage
2	Product 3D data acquisition and reverse modeling	Scanning data processing methods (clutter removal, noise reduction, smoothing, padding, etc.) Reverse modeling methods for surfaces and solids Requirements for data processing of scanning model Model data export method Knowledge of comprehensive professional competence	Data processing of scanned data The ability to reconstruct models from valid data of polygon models and create editable CAD models Recovery of missing data of redesigned object elements from available data of polygon model to design state of product Capable of exporting data models as required Analyze the accuracy of the sample piece according to the functionality of the sample piece, and apply it in the reconstruction of the model, so as to improve the processing economy	20%
3	Product Model Repair	Software basics for reverse modeling Structure and function of sample piece Capable of point cloud data sampling and noise reduction Grid data encapsulation Grid data patching and optimization Methods of scanning data processing Grid data patching and optimization Methods of scanning data processing Method of hole identification Model repair techniques Reverse modeling methods for surfaces and solids Knowledge of comprehensive professional competence	Capable of developing model repair strategies Be able to find the repair position according to the functionality of the sample piece and the damage of the sample piece Capable of point cloud data sampling and noise reduction Grid data encapsulation Grid data patching and optimization Be able to apply software to fix different types of defects in the data model with different methods Reverse modeling of surfaces and solids with digital modeling software Analyze the accuracy of each part of the sample according to the functionality of the sample, and apply it in the reconstruction of the model to improve the processing economy	10%
4	Product 3D digital detection	Knowledge of mechanical drawings Principles of 3D digital scanning equipment Knowledge of data processing for scanning models Operating knowledge of inspection software Alignment principle of scanned data and CAD	Can read CAD drawings Capable of developing inspection strategies prior to inspection Capable of scanning data coordinate system alignment conversion Capable of extracting features of points, lines, faces, holes Capable of setting inspection tolerances Capable of GD&T form and location tolerance evaluation	10%

Table 1 (*continued*)

NO.	Skill Module	Knowledge Requirement	Skill Requirement	Percentage
4	Product 3D digital detection	Knowledge of 2D and 3D dimensional inspection Knowledge of inspection methods and data acquisition GD&T inspection knowledge Basic knowledge of test report Knowledge of comprehensive professional competence	Capable of creating single and composite benchmarks Ability to use and create report templates Analyze the accuracy of each part of the sample piece according to the functionality of the sample piece, find out the out-of-tolerance part during the inspection, provide basis for sample piece inspection and digital/analog reconstruction, and improve the economical efficiency and environmental protection of processing.	10%
5	Optimized product design and manufacturing	Knowledge of mechanical design and mechanical parts Integrated design philosophy Knowledge of topology optimization Knowledge of mechanical properties Operating principle of metal printer Material properties commonly used for metal printing How to use the metal printing slice software Operation method of metal printer and accessory equipment Metal printing parameter settings (printing quality parameters, filling parameters, printing speed, temperature parameters, support parameters, etc.) Metal printing after-treatment technology (taking parts, removing supports and polishing) Metal printing quality control and inspection methods Troubleshooting methods for common use of metal printer Knowledge of comprehensive professional competence	Capable of applying software for integrated design Be able to use topology optimization software to reduce the weight of the product and meet the mechanical property requirements Formulate the optimized design scheme according to the functional requirements of the product The printing parameters of the metal printer can be reasonably set according to the product design and material characteristics Effective supporting structure can be designed to ensure printing process stability and product accuracy Capable of monitoring the printing process and timely discovering and solving possible problems Capable of carrying out necessary post-treatment for printed parts, such as removing supports, heat treatment, machining, etc Be able to use appropriate tools and methods to inspect the quality of printed documents and ensure that the products meet the design requirements	20%
6	Product innovation design and production	Mechanical transmission principles, types and relevant application knowledge Knowledge of mechanical transmission structure design Knowledge of mechanical connection design Knowledge of innovative design Operating principle of light curing printer	Be able to design the structure of the mechanism according to the principle scheme of the mechanism Be able to use innovative design methods to design new products that meet functional requirements and coordinate with a given product	

Table 1 (*continued*)

NO.	Skill Module	Knowledge Requirement	Skill Requirement	Percentage
6	Product innovation design and production	(SLA) Knowledge of the material properties of photosensitive resins How to use the photocured printslice software Setup of printing parameters for photocuring (printing quality parameters, filling parameters, printing speed, temperature parameters, support parameters, etc.) Operation and use methods of light curing printer and accessory equipment Photocuring printing post-processing methods (removing parts, removing supports and polishing) Product assembly methods Knowledge of comprehensive professional competence	Capable of building and optimizing 3D models using CAD software to accommodate photocurable printing processes Be able to design proper supporting structure for the model, reduce deformation during printing and improve printing success rate Slicing software can be used for slice processing and reasonable setting of printing parameters to obtain high-quality printing results Capable of monitoring and adjusting parameters during printing to cope with possible problems. Be able to remove the printed parts, and carry out post-processing steps such as cleaning, removing support and post-curing	15%
7	Product fixture (inspection tool) design and manufacturing	Design philosophy of clamps and gauges (positioning, support, clamping, fast detection, etc.) Knowledge of mechanical design and engineering drawings Knowledge of material mechanics Usage of FDM printing slice software Setting of FDM printing slice parameters (printing quality parameters, filling parameters, printing speed, temperature parameters, support parameters, etc.) FDM printing and auxiliary equipment operation method Troubleshooting methods for common use faults of FDM printing equipment Post-printing treatment methods of FDM products (taking parts, removing supports and polishing) Knowledge of comprehensive professional competence	Be able to creatively design fixtures or gauges according to product functions and operation requirements Be able to use CAD software for detailed design of fixtures or inspection tools Slicing software can be used for slice processing, and reasonable parameters can be set Capable of selecting and using printing equipment to print products Capable of troubleshooting common problems Be able to remove the printout from the platform to ensure the safety and completeness of the printout Capable of post-processing printouts (removing support, sanding, smoothing) Capable of performing functional tests on assembled fixtures or gauges Be able to consider the work orientation, functionality, economical efficiency and innovation of products during printing and assembly	20%
Total				100

5.2 Training requirements

5.2.1 Content Introduction

In order to ensure the quality of the competition and the absolute safety of the actual operation, all participants must participate in the training at the designated institution using the equipment specified by the competition committee. Learn safety protection measures and standard operation of competition equipment, and participate in the competition after passing the training and examination.

5.2.2 Training time

5 Days.

5.2.3 Training contents

The training contents are as follows.

a) FDM 3D printing process and equipment operation;
b) LCD light curing 3D printing process and equipment operation;
c) Metal 3D printing process and equipment operation;
d) Fixture and fixture design and case analysis;
e) Case analysis of product motion simulation design;
f) Integrated 3D printing design and case study;
g) FDM 3D printing forming and post-processing;
h) LCD light curing 3D printing molding and post-processing;
I) Metal 3D printing forming and post-processing;
j) Reverse design and 3D digital inspection software operation and case analysis;
k) 3D scanner operation;
l) Product topology optimization and weight reduction design.

5.2.4 Training teachers

Have the professional technical title of deputy senior or above or the professional qualification of technician or above, and be familiar with the professional knowledge and operation skills of the profession involved in the competition.

5.3 Participants

5.3.1 Age requirements

Over 16 years of age and under 50 years of age without gender restrictions.
At the same time, we also support and encourage young people under the age of 16 who are familiar with the professional knowledge and operational skills involved in the competition to participate, and we will ensure to provide software/hardware support for participants with disabilities.

5.3.2 Group mode

There are 4 participants, including 1 player, 1 interpreter, 1 trainer and 1 leader.

6 Competition content

6.1 Competition task

The competition is divided into six tasks, with a total time of 11 hours, as follows.
Task 1: Product 3D data acquisition and reverse modeling (2 hours)
Use the given 3D scanning equipment to conduct 3D scanning on the product to obtain the point cloud data of the product appearance. The player conducts data processing and reverse modeling. The drawn CAD model shall eliminate the original object defects caused in the process of production, operation, failure and maintenance (nick, burr, welding, brazing, chip, etc.). The task mainly assesses the ability of the player in 3D data acquisition, data processing and reverse modeling of curved surface.

Task 2: Product model repair (1.5 hours)
Use the 3D point cloud data of a given product to analyze the functions to be realized by the part, conduct reverse

modeling and reconstruct the missing part of the product. The manufactured CAD model shall eliminate the original object defects caused during production, operation, failure and maintenance (nick, burr, welding, brazing, chip, etc.), and finally generate ISO standard engineering drawings. This task mainly assesses the player's ability to analyze and model the missing parts of the product and to draw engineering drawings.

Task 3: Product 3D digital inspection (1 hour)
The three-dimensional point cloud data, CAD data and part drawings in PDF format of a given product are used to mark the overall appearance deviation of the part, mark the deviation of the specified coordinate position point, measure the specified dimension and detect the form and location tolerance, and issue the inspection report. This task mainly assesses the size measurement and geometric form and position tolerance test of the product and the ability to issue the test report.

Task 4: Optimized product design and production (2.5 hours)
The three-dimensional model of a given product is used for integrated design. The integrated part is optimized by the topology optimization method (meeting a certain amount of weight reduction design without changing the original mechanical properties under the given bearing capacity). Reasonable 3D printing process is selected to produce the integrated part after topology optimization, and the post-processing of the printed part is completed. This task mainly assesses the player's ability in integrated design and topology optimization design, and the ability to use 3D printing equipment to complete the designated product processing tasks in time and with high quality in the best path and method, and the post-processing of printing models.

Task 5: Innovative design and production of products (1.5 hours)
Use the 3D point cloud data of a given product to design another product matched with it to meet the given functional requirements. Select a reasonable 3D printing process to produce another product, and complete the post-processing of the printed copy. This module mainly assesses the player's ability in the innovative design of new products, the use of 3D printing equipment in the best path and method to complete the designated product processing tasks in time and with high quality, and the post-processing of printing models.

Task 6: Product fixture (inspection tool) design and manufacturing (2.5 hours)
Using the 3D data model of a given product, it is required to install a fixture during the 3D inspection of the product, or design an auxiliary inspection tool that does not require a measuring tool or a gauge to quickly inspect whether the mating part of the product and another mating part meet the requirements, select a reasonable 3D printing process to produce and complete the post-processing of the printed part, and assemble the fixture or inspection tool to meet the functional requirements. This module mainly assesses the design capacity of the clamp or inspection tool of the player and the operation of 3D printing equipment, 3D Print Post Processing and assembly capacity of the product.

6.2 Score specific gravity

The score proportion of competition see the table 2.

Table 2 Score proportion of competition

Task No.	Task Name	Percentage（%）
Task 1	Product 3D data acquisition and reverse modeling	21
Task 2	Product model repair	10
Task 3	Product 3D digital detection	10
Task 4	Optimized product design and manufacturing	22
Task 5	Product innovation design and production	16
Task 6	Product fixture (inspection tool) design and manufacturing	21
Total		100

6.3 Duration of competition

The duration of competition see the table 3.

Table 3 Duration of competition

Task No.	Task Name	Duration（min）
Task 1	Product 3D data acquisition and reverse modeling	120
Task 2	Product model repair	90
Task 3	Product 3D digital detection	60
Task 4	Optimized product design and manufacturing	150
Task 5	Product innovation design and production	90
Task 6	Product fixture (inspection tool) design and manufacturing	150
Total		660

6.4 Issue release

The expert group shall release the competition sample questions and scoring standards on the official website of the competition one month before the formal competition to ensure 80% of the questions are consistent with the formal competition and 80% of the questions are consistent with the idea.

6.5 Confidentiality requirements

6.5.1 Examination paper confidentiality

It shall be kept by designated confidential working group personnel after volume grouping, printing, bagging and pasting of sealing labels.

6.5.2 Unsealed examination paper

The invigilator will unseal the examination paper at the competition site.

6.5.3 Sample storage

It shall be stored in a designated place and kept by a specially-assigned person to prevent loss and exchange.

6.5.4 Filing of data

The paper data for score evaluation shall be kept for 3 years, and the relevant electronic data and relevant competition process image data shall be kept by the sponsor for a long time.

7 Evaluation criteria

7.1 Judgment principle

7.1.1 Comprehensive principle

Based on the principle of "fairness, fairness, openness, science and innovation", the event expert group and the judging group are responsible for the evaluation of the event results. Comprehensively evaluate the competitors from design, equipment operation to civilized production, etc.

7.1.2 Principle of Module Independence

To ensure fairness, accuracy, and objective evaluation, each module in the competition must be conducted and assessed independently. The performance or outcome of one module shall not interfere with the conditions, execution, or assessment of any subsequent module.This principle ensures:

a) Isolated assessment of specific skill areas;

b) Clear diagnosis of participant proficiency per module;
c) Fair competition regardless of earlier task outcomes;
d) Consistency in evaluation and scoring.

Each module shall therefore:

a) Provide a neutral and clean working environment;
b) Supply independent tools, materials, and data;
c) Contain self-contained instructions and goals;
d) Allow participants to start without relying on outputs from previous tasks.

Judges must evaluate only the task-specific competencies demonstrated within each module's scope, based on predefined technical criteria.

7.2 Evaluation and measurement score distribution

The evaluation score (subjective) and measurement score (objective) are allocated for the preparation of scoring scheme and competition task, and the specific score distribution is shown in table 4.

Table 4 Assignment of task evaluation and measurement scores

Task No.	Task name	Evaluation score	Measurement score	Total
Task 1	Product 3D data acquisition and reverse modeling	2	19	21
Task 2	Product model repair	1	9	10
Task 3	Product 3D digital detection	0	10	10
Task 4	Optimized product design and manufacturing	4	18	22
Task 5	Product innovation design and production	3	13	16
Task 6	Product fixture (inspection tool) design and manufacturing	3	18	21
Total		13	87	100

7.3 Evaluation score

Scoring method of assessment: 4 judges are in one group, one of which is a rotational judge, i.e., the judges in the same group are scored, and cannot score their own competitors. The 3 judges score separately, give the weight score for one player's assessment item, get the average weight score and calculate the actual score. The difference between the weight points of judges can be less than or equal to 1 point. If it exceeds 1 point, it is necessary to make an evaluation reason statement for the assessment items of the player, and give a reasonable score under the consideration and supervision of the adjudicator. table 5 shows the weight and weight of evaluation.

Table 5 Weight and weight of evaluation

Weight score	Description of requirements
0 point	In all respects below industry standards, including "no attempt" or unacceptable
1 point	Meet industry standards
2 point	Meet industry standards and in some respects exceed standards
3 point	To reach the excellent level expected by the industry

7.4 Measurement points

Measurement scoring mode: several scoring groups are set according to the task, and each group is composed of 4 judges. All judges in each group shall discuss together, and only one point shall be given after agreement on the actual score of the player in this item. See table 6 for an example of measurement score.

Table 6 Example of measurement scoring

Type	Example	Max Score	Correct score	Incorrect score
Full or zero	For completeness of a printout, a score of 1 is given, and there are only two possibilities for a competitor to score, either full or zero	1	1	0
Out of full score	There are 10 key dimensions in a printout, with the maximum score of 2 points; deduct 0.2 point if one dimension fails to meet the requirements; deduct 4 points if the other dimension fails to meet the requirements	2	1.2	0.8
Deduction	For 5 key dimensions of a reverse modeling, the maximum score is 5 points, 1 point for one meeting the requirements, and 2 points for the competitor meeting the requirements	5	2	3

7.5 Judgment process

7.5.1 Result scoring

Evaluate and score the competition results submitted by the players according to the evaluation criteria of the events.

7.5.2 Deduct points for violation

Score will be deducted in case of the following situations:

a) In the process of completing the work task, if the accident is caused by improper operation, deduct the total score of 10-15 points, and if the situation is serious, cancel the competition qualification.
b) If the equipment provided by the venue is damaged due to illegal operation, the environment of the venue is polluted and other serious behaviors that do not conform to the professional norms, deduct 5 to 10 points according to the circumstances, and cancel the competition qualification if the situation is serious.
c) If it disturbs the order of the court and the work of the judges, deduct 5~10 points according to the circumstances. If the situation is serious, cancel the competition qualification.
d) Points shall be deducted if the tools are not placed tidily, the operation process is disordered, the dressing is not standard and the data is archived incompletely according to the competition regulations and the requirements of the task book.

7.5.3 Spot check and review

In order to ensure the accuracy of the performance statistics, the supervision group shall review the results; Sampling inspection coverage shall not be less than 30%. The supervision group shall timely inform the expert group leader of the errors found in the re-inspection in written form, and the expert group leader shall correct the results and sign for confirmation.

7.6 Sorting method

Each scoring group shall score the module in charge, and the process score shall be combined with the post-event result score, and the workpiece completed by the player on the same day shall be scored. No one is allowed to modify the USB flash disk data after storage, and the data must be sealed and submitted to the chief judge for safekeeping. The evaluation score form and measurement score form shall be signed and confirmed by each participating judge and submitted to the expert group leader for safekeeping.

7.7 Scores ranking

Score Summary Ranking. If the total score is the same, compare the results of task 1, and the higher one shall be ranked at the top. If the total score is the same, the ranking is determined by the scores of Task 4, Task 5, Task 6, Task 1, Task 2 and Task 3.

7.8 Performance release

The closing ceremony announced the game results.

7.9 Awards setting

7.9.1 Certificates

The teams will be granted a Certificate of Award issued by the BRICS Business Council.

7.9.2 Gold, silver, bronze and winner awards

The teams of BRICS countries are ranked uniformly, and the top 3 competitors in the competition project will be awarded with gold, silver, copper medals and certificates; Winner medals and certificates shall be issued to the top 3 players but above 1/2 of the participants; And add additional award categories of “Technical Innovation,” “Sustainable Solutions,” and “Best Team Collaboration.” Each participant will receive structured feedback based on the competition’s evaluation criteria, and the skills acquired during the competition will be formally recognized in the form of subject certificates and skill passports; Certificates issued by other participants.

7.9.3 Other awards

Issue an execution certificate to the members of the expert panel participating in the arbitration and the executive judgment; The organization making outstanding contributions to the competition will be awarded the "Outstanding Contribution Award"; The "Excellent Organization Award" will be awarded to the countries that actively organize the participation, carry out the pre-competition selection training and have no violations during the competition.

7.9.4 Technical review

The basic points of technical review (summary) are as follows:

a) Competition purpose, technical standards and evaluation. Composition of competition modules, proportion among modules and main purpose of arrangement of modules. Main technical standards and requirements for each module proposition. The process, rule, method and case analysis of judgment;
b) Analysis on competition of participants. Analyze the overall competition results and the specific performance of the participants. Through the comparative analysis of the competition results (workpiece) of the participants, summarize the skill highlights and problems reflected in the competition process, and put forward opinions and suggestions.

8 Judge

8.1 Responsibilities of judges

8.1.1 Responsibilities of chief expert

The responsibilities of chief experts are as follows.

a) Setting and roles.The chief expert is the top person in charge of the judging team, and one is appointed, mainly responsible for the overall guidance and supervision of the judging activities of the events.
b) Formulation and approval of rules.Organize the preparation of evaluation standards and rules before the game, and review and confirm the final evaluation rules.
c) Dispute handling. In the event of any judgment dispute during the competition, the chief expert must intervene immediately, and the arbitration team will make a determination to ensure the problem is resolved fairly and quickly.
d) Coordination and management.Coordinate the work of deputy chief experts, judges, leaders, translators and other team members to ensure smooth judgment process and timely and effective information communication.

8.1.2 Responsibilities of deputy chief expert

The responsibilities of deputy chief experts are as follows.

a) Setup and assistance.One deputy chief expert is appointed to assist the chief expert and jointly ensure the efficient operation of judgment.
b) Responsibility of agent.When the chief expert is unable to perform his or her duties for some reason, he or she will automatically take over the duties of the chief expert to ensure the continuity of the judgment work.

c) Daily work.Participate in the discussion and formulation of evaluation standards, assist in solving technical problems in the evaluation process and provide professional opinions.

8.1.3 Judge

8.1.3.1 Team composition.

There are 3-5 judges as the core judging force to directly participate in the judging of events.

8.1.3.2 Implementation of judgment

Independently and objectively judge the technical ability, work quality, innovation and other aspects of the team according to the established evaluation standards.

8.1.3.3 Record and report.

The judgement process shall be recorded in detail and the judgement report shall be submitted to the chief expert or deputy chief expert if necessary, indicating the judgement basis and score distribution.

8.2 Selection and generation

8.2.1 Qualification requirements

Candidates of judges shall have deep professional knowledge, rich practical experience and good international perspective in additive manufacturing field.

8.2.2 Nomination and application

The candidate list is generated through industry recommendation, individual application or recommendation of the last excellent judge.

8.2.3 Review procedures

The BRICS Organizing Committee shall organize a review team to conduct a comprehensive review according to the professional background, experience, foreign language ability and past judgment performance of the candidates.

8.2.4 Setup of expert database

Input qualified experts into the expert database after review.

8.2.5 Expert generation

The committee will randomly select experts from the expert database to form an expert team. It shall be formally appointed by the organizing committee and the list of judges shall be published.

8.3 Judge management

8.3.1 Training

8.3.1.1 Training contents

The latest development trend of additive manufacturing technology, international judgment criterion, judgment system operation, ethics and crisis handling, etc.

8.3.1.2 Training mode

The online and offline methods are combined, including theoretical learning, case analysis, practice drills, etc.

8.3.1.3 Assessment and verification.

Upon the completion of the training, the written examination and practical operation examination shall be passed to ensure that the judges meet the post standards.

8.3.2 Evaluation

8.3.2.1 Evaluation period

During and after the game, the judges' professional ability, fairness, teamwork attitude and professional ethics shall be comprehensively evaluated.

8.3.2.2 Assessment method

Self-assessment, mutual assessment by judges, team feedback and observation by the organizing committee are adopted.

8.3.2.3 Application of results

The evaluation results serve as the reference basis for the judges to participate in similar events in the future. Those who perform excellently will be commended, and those who fail will be guided or adjusted.

9 Leader

Team leaders are responsible for the daily management and discipline of their respective teams, ensuring that they comply with the rules and order of the competition. As liaisons between the teams and the referees, they assist in communicating information and answering questions from the teams regarding the rules of the competition.

10 Translator

Translation services are provided in multiple languages to ensure smooth communication between participating teams, referees, and staff from non-native English-speaking countries. Assistance is provided to facilitate cross-cultural understanding, ensure the accuracy of information during the judging process, and reduce misunderstandings caused by language differences.

11 Technical platform

11.1 Software platform

11.1.1 Operating system

Win 10 64 bit Astra Linux、Linux_Mint、 HarmonyOS PC, etc.

11.1.2 Text processing software

MS-Office, WPS-Office, CalliSuite, Adobe Reader, etc.

11.1.3 Industrial design software

Main functions: 3D modeling, surface design, assembly design, rendering and visualization, engineering analysis, 2D drawing, data exchange, material library and texture library, parametric design and reverse engineering. Software such as AutoCAD, Developer, Professional, AutoCAD, Fuse, SOLID, NX, CATIA, Creo and KOMPAS-3D shall be selected.(The software is provided by the organizer, and the version is based on the mainstream version number available on the market.)

11.1.4 Reverse modeling and inspection software

Main functions: data acquisition and processing, model reconstruction, error analysis, dimension measurement, form and position tolerance detection, feature extraction and comparison, report generation, data storage and management, CAD software integration. Geologic Design X, Geologic Control X, PolyWorks, Geologic Wrap, RGK and other software are selected.

11.1.5 Structure optimization software

Main functions: model establishment and import, finite element analysis (FEA), optimization algorithm application, multi-objective optimization, parametric design, sensitivity analysis, fatigue analysis, optimization result visualization, interface with other software and report generation. Altair Explore, AutoCAD Fuse and other software shall be selected.

11.1.6 Three-dimensional scanning software

Main functions: data acquisition and import (play,. sta,. obj), point cloud processing, surface reconstruction, model editing and repair, measurement and analysis, texture mapping, data output, visualization and rendering. Scan Viewer, EX Scan Pro and other software are selected.

11.1.7 Printing slice software

Main functions: model import and format support (STL, OBJ, 3MF), model viewing and editing, slice setting, temperature setting, path planning, material setting, G code generation. Cura, PrusaSlicer, Simplify3D, Materiali Magics, Vo Addition, Prusa Slicer, Chitbox, Creativity, HALOT BOX and other software are selected.

11.2 Hardware platform

11.2.1 Computer

Processor i7 generation 11 dual-core performance above / 32 G memory / 8 G video memory / SSD 512 G / video card NVIDIA series GTX 3060 and above/gigabit network port.

11.2.2 Scanner

The main technical specifications of scanner see the table 7.

Table 7 Main technical specifications of scanner

Technical Indicator Name	Technical Indicator Requirements
Scan Mode	Standard scan mode, hyperfine scan mode
Box Selection Fine Scan	Support
Scan Deep Hole And Dead Angle	Support
Splicing Of Small Pieces	Support
Scan Rate	Standard scanning mode: more than 500000 measurements/second; Superfine scan mode:> 200000 measurements/sec
Category of Laser	Class II (eye safety)
Minimum Resolution Ratio	Standard scanning mode: 0.05 mm; Ultrafine scanning mode: 0.01 mm;
Accuracy	Max. 0.02 mm
Precision of Volume	0.015 mm+0.035 mm/m；
Depth of Field	450 mm
Datum Distance (Datum)	300 mm
General Requirements	Operating system: WIN10 and above systems; MAC system Data format: STL (triangular grid surface), ASC (point cloud),(wireframe format), etc Supporting language: English version, etc

11.2.3 Additive manufacturing equipment

The main technical specifications of Fdm printer see the table 8.

Table 8 Main Technical Specifications of Fdm printer

Technical Indicator Name	Technical Indicator Requirements
Printing Accuracy	±0.1 mm
Printed Layer Thickness	0.1-0.4 mm
Printing Consumables	1.75 mm Diameter Consumables:PLA, ABS, ASA, PETG, PVA, HIPS, PA, PC, etc
Air Filtration	Yes
Power OffAnd Continue Driving	Support
Material Interruption Detection	Support
Slicing Software	Support
Consumable Material Warehouse	Yes
Tool Box	Yes
Leveling Mode	Automatic leveling
Automatic Shutdown	Support
General Requirements	Operating system: WIN10 and above systems; MAC system Data format: GCODE (STL file slice), etc Supporting language: English version, etc

The main technical indexes of light curing printer see the table 9.

Table 9 Main technical Indexes of light curing printer

Technical Indicator Name	Technical Indicator Requirements
Printed Layer Thickness	0.05-0.15mm
Fast Printing	1-4s/level
Printing Consumables	Light sensitive resin
Printing Mode	Support U disk offline printing/WIFI printing
Slicing software	Support
Air Filtration	Yes
General Requirement	Operating system: WIN10 and above systems; MAC system Data format: STL, SLC, etc Supporting language: English version, etc

The main technical indexes of metal printer see the table 10.

Table 10 Main technical indexes of metal printer

Technical Indicator Name	Technical Indicator Requirements
Printed Layer Thickness	10-50 μm
Line Scan Speed	≤10000 mm/s
Linear Forming Speed	500-3000 mm/s
Slicing Software	Support
Forming Accuracy	0.05-0.1 mm
Powder Spreading Method	One-way powder spreading
Forming Material	Metal alloy material
General Requirements	Operating system: WIN10 and above systems; MAC system Data format: STL, SLC and other convertible formats Supporting language: English version, etc

12 Site

12.1 Site environment

The site environment requirements are as follows.

a) Stable water, electricity, air source and power supply emergency equipment;
b) The headroom shall not be less than 3.5 m, with good daylighting, lighting and ventilation, and the ambient temperature and humidity shall comply with the equipment use regulations, so as to provide an all-round CCTV monitoring environment;
c) The area of the match position is over 20 ㎡, which is isolated from each other. The players can carry out the competition independently without being affected by the outside world;
d) The width of the main channel of the game field is more than 2 m, meeting the safety emergency evacuation standard.

12.2 Site layout

The site layout requirements are as follows.

a) Such public service areas as maintenance service, medical service and living supply stations are set up in the competition field to provide services for the players and participants;
b) The competition area is provided with such functional areas as player operation area, competition preparation area, judgment area, scoring area, material preparation area, confidentiality room, arbitration room, technical support area, etc. The layout of its work decks is shown in Figure 1, and the site layout is reasonable according to the actual situation of the site.

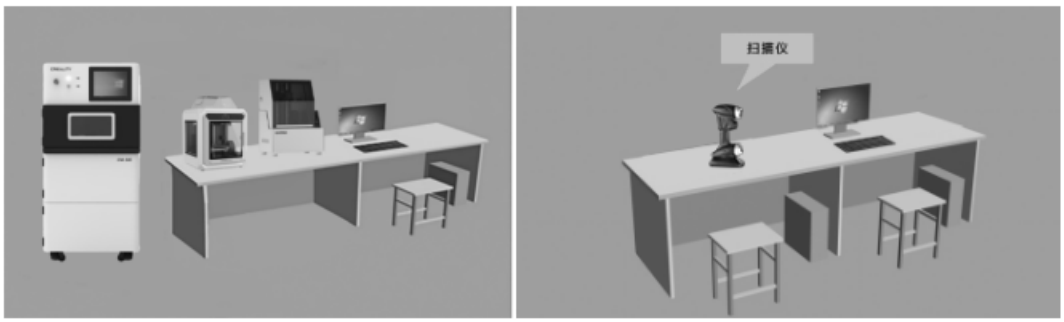

Figure 1 Station Layout

12.3 Site management

The site management requirements are as follows.

a) Warning lines and safety areas shall be set around the field to prevent irrelevant personnel from entering;
b) Observe and interview personnel in the safe passage;
c) At the end of each stage (module) competition, when the participants leave the venue, the adjudicator shall organize the inspection of the facilities, equipment, competition workpiece (results), tools, materials, etc. of each station, and arrange the demobilization uniformly;
d) If the equipment needs to be initialized and parameter restored, the adjudicator, together with the experts and judges, shall deal with it to ensure the consistency of the competition environment.

13 Event Safety

13.1 Safety training

The safety director organizes all judges, staff and players to receive safety training, and can participate in the competition only after passing the training examination.

13.2 Safety facilities

The safety facilities requirements are as follows.

a) The arrangement of the competition field and the equipment and equipment in the competition field shall comply with the safety regulations. Construct in strict accordance with safe construction standards;
b) Necessary safety isolation measures and passageways shall be provided in the field, and complete emergency treatment facilities such as fire extinguishing facilities shall be provided. Safety operation procedures shall be posted at obvious positions, and safety evacuation signs shall be set;
c) Security check equipment shall be set at the entrance of the game field to prevent unauthorized articles from entering.

13.3 Management and restriction of toxic and hazardous substances

The requirements for the management and restriction of toxic and hazardous substances (in accordance with the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) standards) are as follows.

a) Participants and all participants are prohibited from bringing any toxic and hazardous substances into the competition site;
b) Competition chemicals must be accompanied by safe operating instructions. When using dangerous chemicals, wear protective clothing, type A disposable gloves, safety glasses, respirators and other safety protection appliances in accordance with the relevant regulations, and regulate the operation.

13.4 Medical equipment and measures

The competition site must be equipped with corresponding medical personnel and first-aid personnel, as well as corresponding first-aid facilities and plans.

13.5 Recommended personal protective equipment (PPE) by 3D printing technology

To ensure the safety of participants during the operation of various additive manufacturing technologies, the use of the following Personal Protective Equipment (PPE) is recommended, according to the risks associated with each process , see table 11 for details.

Table 11 Personal Protective Equipment (PPE)

Technology	Main Risks	Recommended PPE
FDM (Fused Deposition Modeling)	High temperatures, hot surfaces, plastic particles	Safety goggles,Heat-resistant or handling gloves,Flame-retardant lab coat,Closed-toe shoes
SLA / LCD (Stereolithography / Light Curing)	Toxic liquid resins, chemical vapors	Nitrile gloves,Chemical safety goggles,Chemical apron,PFF2 mask or local exhaust ventilation

Table 11 *(continued)*

Technology	Main Risks	Recommended PPE
SLS / DMLS / SLM (Selective Laser Sintering / Melting)	Flammable powders, laser radiation, heat, inhalation hazards	PFF3 mask or HEPA-filter respirator,Dust-resistant gloves,UV/laser safety goggles,Disposable coveralls or anti-static lab coat,ESD footwear
Binder Jetting / MJF	Fine powders, chemical agents, heat	PFF2/PFF3 mask,Chemical protective gloves,Safety goggles,Chemical protective clothing,Safety boots
Metal 3D Printing (DMLS, EBM, etc.)	Metal dust, explosion risk, extreme heat	HEPA-filter respirator,Heat-resistant and metal-handling gloves,Flame-resistant coverall,Full-face shield,Thermal safety footwear
All PPE must comply with current national and international safety standards (e.g., ISO, GB). Always follow the equipment and material manufacturers' safety guidelines. Printing environments involving powders must include proper ventilation and dust extraction systems.		

14 Event Contingency Plans

In response to various unforeseen circumstances and potential risks that may arise during the competition, the following contingency plans and action protocols have been pre-established:

a) In the event of unexpected issues such as power outages or equipment malfunctions during the competition, on-site referees must promptly verify the situation, contact on-site technical support personnel for resolution, document the details of the incident, complete the time extension log form, and obtain approval from the chief referee before arranging to extend the competition time for the affected participants.

b) Two complete sets of backup equipment are reserved at the competition site. If equipment suffers severe malfunctions or damage not caused by the participants, rendering it unusable, the on-site referees must approve, and the chief referee must confirm, that participants may transfer relevant data to the backup equipment under the supervision of on-site technical support personnel and referees to continue completing the competition tasks.

c) During the competition, each participating team operates independently. If an unexpected situation occurs at a particular competition station, it will not affect the normal competition at other stations and will not impact the results.

d) The competition venue provides backup power supplies and has epidemic prevention points and emergency medical points.

e) In the event of an accident during the competition, the discoverer should immediately report it to the competition organizing committee and take measures to prevent the situation from escalating. The competition organizing committee should immediately activate the contingency plan to resolve the issue and report it to the regional organizing committee. For competitions involving major safety issues, the regional organizing committee will decide whether to suspend the competition. Afterward, the regional organizing committee should report the detailed circumstances to the national organizing committee.

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