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## Competition for industrial design technology competition

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## Foreword

Attention is drawn to the possibility that some of the elements of this document may be the subject of intellectual property. The issuing body of this document shall not be held responsible for identifying any or all such patent rights.

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# Competition for industrial design technology competition

## 1 Scope

This document specifies the basic requirements, safety regulations, assessment weights, competition score evaluation, and award setting for industrial design technology competitions, including but not limited to personnel, venue, and equipment resource requirements for industrial design technology competitions. This document is applicable to the organization and organization of industrial design technology competitions.

## 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

#### **industrial design technology**

comprehensive treatment of industrial products in terms of material, structure, process, form, surface treatment and decoration by means science, technology and innovation, so as to make them have practical, economical and beautiful quality

### 3.2

#### **industrial design technical engineer**

engineering technicians engaged in the research, design, and industrialization of the functions, structures, forms, and packaging of design objects, as well as the design technology path

### 3.3

#### **computer aided design**

use of a computer (or workstation) to assist designers in creating, modifying, analyzing, and optimizing designs

### 3.4

#### **innovative design**

innovative design refers to a kind of practice activity that gives full play to the imagination and creativity of designers, uses the existing relevant scientific and technological achievements to carry out innovative ideas and designs scientific, creative, novel and practical achievements

### 3.5

#### **digital prototype**

refers to a digital model established for a product using industrial software, including parts, components, etc. The digital model contains all the information of the and can be used in various stages such as product design and manufacturing. It is the foundation for achieving product analysis, optimization, verification, manufacturing, and design expression

## 4 Competition overview

### 4.1 Name

Industrial design technology.

### 4.2 Name of occupation

The occupational names (types of work) involved in the competition are coded and named in the Code of Occupational Classification of the International Standard Classification of Occupations, 2008 (ISCO-08) for 2163 Product and garment designers. The national occupational skill standard level is above Level III.

### 4.3 Purpose

The industrial design skill competition is an organized mass industrial design technology professional skill competition activity based on the coding national occupational skill standard of industrial (product) design engineering and technical personnel, the common needs of BRICS countries in manufacturing upgrading and cross-border trade, and the needs of cultivating high-skilled talents in industrial design who are adaptable to international collaboration

## 5 Basic requirements

### 5.1 General world skills standard specification requirements

This specification specifies the basic knowledge, understanding and specific skills required for industrial design technology and profession to achieve the best level of technical and professional work practice, reflecting the understanding of the job and position in the industry. The purpose of the skills competition is to reflect the high-level international practice described in this standard specification so that it can be implemented. This specification is therefore a guide to the training and preparation required for skills competitions.

In skills competitions, knowledge and understanding of the technical skills of industrial design will be assessed by evaluating the actual skill performance of the competitors and determining their professional level. The standard specification is clearly divided into sections clearly defined by title and reference number. Each section is assigned a percentage of points to indicate its importance in the skills standards specification. The sum of all score percentages is 100%.

Scoring schemes and competition items only evaluate skills specified in this skill standard specification. They reflect as fully as possible the requirements of the skill standards and specifications under the specified conditions of the skill contest.

### 5.2 Generic world skills standards specification form

Skills requirements and scoring specification see table 1.

**Table 1 Skills requirements and specification schemes**

| No. | Skills module                    | Knowledge requirements  | Skill requirements   | Percentage (%) |
|-----|----------------------------------|---|--|----------------|
| 1   | Work organization and management | <ul style="list-style-type: none"> <li>Current health and safety regulations related to the industrial design technology industry</li> <li>Use and maintain personal protective equipment and clothing</li> <li>Recommendations and information published by the supplier or manufacturer of the product and equipment</li> <li>Procedures for maintenance and use of specialised equipment</li> <li>Terms and symbols related to industrial design technology</li> <li>Terms and symbols related to mechanical design and manufacturing process</li> </ul> | <ul style="list-style-type: none"> <li>Be able to apply occupational health and safety regulations to the mechanical design and manufacturing industry</li> <li>Be able to use and maintain personal protective clothing and equipment</li> <li>Capable of setting, using, adjusting and maintaining all professional equipment</li> <li>Promote safe and healthy operations in the workplace</li> <li>Be able to apply recommendations and information published by product and equipment suppliers or manufacturers</li> <li>Compliance with manufacturer's safety instructions</li> </ul> | 5              |
| 2   | Core component modeling          | <ul style="list-style-type: none"> <li>Knowledge of mechanical drawings</li> <li>Operating principle of 3D digital scanning equipment</li> </ul>  | <ul style="list-style-type: none"> <li>Capable of reading and understanding CAD drawings</li> <li>Capable of developing sample scanning and reverse modeling strategies</li> </ul>   |                |

Table 1 (continued)

| No. | Skills module           | Knowledge requirements   | Skill requirements   | Percentage (%) |
|-----|-------------------------|--|--|----------------|
| 2   | Core component modeling | <p>Strengths and weaknesses of various types of 3D scanning digital equipment and their basic technologies</p> <p>Equipment technical features for the accuracy and speed of optical 3D digital scanning, and the importance of equipment calibration and requirements for calibration and digital conditions to ensure the operational feasibility and declared accuracy</p> <p>Scanning data processing methods (clutter removal, noise reduction, smoothing, padding, etc.);</p> <p>Requirements for data processing of scanning model</p> <p>Model data export method</p> <p>Software basics for reverse modeling</p> <p>Methods of scanning data processing</p> <p>Method of hole identification</p> <p>Model repair techniques</p> <p>Reverse modeling methods for surfaces and solids</p> <p>Digital software 3D modeling and 3D assembly methods</p> <p>Knowledge of comprehensive professional competence</p> | <p>Be able to adjust and calibrate the scanning equipment</p> <p>Capable of developing scanning plans based on the characteristics of the scanned parts</p> <p>Capable of performing pretreatment work according to scanning scheme (disassembly, cleaning, matt coating, etc.)</p> <p>Optical marking according to scanning scheme</p> <p>Data acquisition with scanning equipment</p> <p>Capable of patching, optimization, packaging and other data processing of scanned data</p> <p>The ability to reconstruct models from valid data of polygon models and create editable CAD models</p> <p>Capable of exporting data models as required</p> <p>Capable of performing feature analysis and planning modeling steps based on the given product part drawings</p> <p>Capable of accurately drawing 2D sketches required for modeling</p> <p>Be able to select the appropriate modeling tools to create the part solid modeling</p> <p>Parts can be installed in the component environment, and the fixed constraint of parts can be reasonably set according to the characteristics of parts</p> <p>Use part movement and rotation tools in the part environment to adjust part position or placement angle</p> <p>The freedom of the parts in the component can be restricted by the position restraint tool</p> <p>Be able to specify how the part moves by means of motion restraint tools</p> <p>It can specify the position relationship and motion relationship of parts and components by connecting tools</p> | 10             |
| 3   | Design of special parts | <p>Mechanical transmission principles, types and relevant application knowledge</p> <p>Knowledge of mechanical transmission structure design</p> <p>Knowledge of mechanical connection design</p> <p>Knowledge of mechanical drawings</p>  | <p>Capable of interpreting technical specifications related to industrial design</p> <p>Be able to design the structure of the mechanism according to the principle scheme of the mechanism</p> <p>Be able to determine the material of the part according to the given working conditions</p> <p>Be able to carry out structural statics finite element analysis of product parts and obtain stress and strain of parts corresponding to "dangerous point"</p> <p>Be able to add part material information and contact information between parts</p>  | 20             |

Table 1 (continued)

| No. | Skills module                    | Knowledge requirements  | Skill requirements   | Percentage (%) |
|-----|----------------------------------|---|--|----------------|
| 3   | Design of special parts          | <p>Quality, strength and application knowledge of metal and non-metallic materials</p> <p>Part engineering drawing generation, view setting, editing and annotation methods of 3D software</p> <p>Scenario, light source setting and rendering output method of 3D software part rendering picture</p> <p>Animation production method for assembly or disassembly of 3D software</p> <p>D software for finite element analysis of parts</p> <p>1 Knowledge of comprehensive professional competence</p> | <p>Be able to manually add constraints and load conditions required for stress analysis according to application conditions of parts</p> <p>The stress analysis report can be obtained by further analyzing the stress and strain of parts through automatic grid division method</p> <p>Capable of creating part engineering drawing views, view editing, dimensioning, technical requirements annotation</p> <p>Create assembly engineering drawing view, edit, annotate, sort out and set detail bar</p> <p>Be able to select appropriate scene style and light source style in the rendering module, set appropriate rendering parameters, and output product renderings</p> <p>Complete the disassembly of parts by adjusting the position of parts through linear motion and rotational motion, and create the assembly or disassembly view of product parts</p> <p>Animation of product assembly or disassembly process based on presentation view</p> <p>Be able to consider the intuition, functionality, economical efficiency and innovation of the product in the design</p> |                |
| 4   | Mechanism creative design        | <p>Mechanical transmission principle, type and relevant application knowledge</p> <p>Design knowledge of mechanical transmission structure</p> <p>Knowledge of mechanical connection design</p> <p>Lightweight related knowledge</p> <p>Knowledge of comprehensive professional competence</p>  | <p>Be able to interpret technical specifications related to industrial design</p> <p>Be able to design the structure of the mechanism according to the principle scheme of the mechanism</p> <p>Be able to conduct lightweight analysis and optimization of parts according to the requirements of parts weight and safety factor</p> <p>Be able to consider the functionality, economy, environmental protection, innovation and social acceptability of the product in the design</p>  | 20             |
| 5   | Realization of product functions | <p>Basic knowledge of computer mapping</p> <p>Knowledge of modeling methods for digital modeling software</p> <p>Technical specifications for product assembly</p> <p>Digital software 3D modeling and 3D assembly methods</p> <p>Mechanism motion simulation method and result output method</p> <p>Knowledge of comprehensive professional competence</p>   | <p>The ability to create digital models of parts using 3D modeling software;</p> <p>Create assembly and animation of product with 3D modeling software;</p> <p>Capable of drawing exploded drawings of parts using computer plotting software</p> <p>Be able to consider meeting the functional, economic, environmental, innovative, and socially acceptable requirements of the product during design</p>  | 15             |

Table 1 (continued)

| No.   | Skills module                 | Knowledge requirements  | Skill requirements  | Percentage (%) |
|-------|-------------------------------|---|---|----------------|
| 6     | Rapid production of prototype | <p>3D printer commissioning (setup and connection, printer calibration)</p> <p>Selection of 3D printing process method and preparation of printing process flow</p> <p>How to use 3D printing slice software</p> <p>Setting of 3D printing slice parameters (printing quality parameters, filling parameters, printing speed, temperature parameters, support parameters, etc.)</p> <p>Methods for 3D printing and operation of auxiliary equipment</p> <p>Troubleshooting methods for common use of 3D printing equipment</p> <p>Post-processing methods for 3D printing (taking parts, removing supports and polishing)</p> <p>Precision inspection (outline precision measurement, outline surface inspection, defect detection, etc.)</p> | <p>Be able to determine the normal connection of the printer and conduct horizontal calibration of the printer</p> <p>Be able to prepare corresponding printing scheme and process according to product and part characteristics</p> <p>Slicing software can be used for slice processing, setting reasonable parameters and outputting 3D printing program</p> <p>Capable of selecting and commissioning printing equipment for printing</p> <p>Be able to handle common use faults</p> <p>Be able to remove the printout from the platform to ensure the safety and completeness of the printout</p> <p>Post processing of printouts</p> <p>Reasonable measuring tools can be selected for inspection</p>                                   | 10             |
| 7     | Manufacturing challenges      | <p>Knowledge of tooling fixture design</p> <p>Basic knowledge of mechanical drawings</p> <p>Knowledge of tolerance fits and manufacturing accuracy levels;</p> <p>How to use 3D printing slice software</p> <p>Setting of 3D printing slice parameters</p> <p>Use of 3D printing equipment</p> <p>3D printing post-processing method</p> <p>Formulation of NC process route</p> <p>Basic knowledge of NC machining and equipment use</p>  | <p>Be able to design tooling fixtures according to the given blank and part size requirements</p> <p>Be able to use additive manufacturing method to complete the manufacturing of special tooling fixtures, including the selection of 3D printing direction, software and equipment use, post-processing</p> <p>Be able to select the material reduction manufacturing method according to the dimensional accuracy requirements of parts, prepare the process documents and select the processing parameters</p> <p>Be able to conduct manual programming and software programming for material reduction manufacturing, and adjust the size of processed parts</p> <p>Be able to measure key dimensions of parts with measuring tools</p> | 20             |
| Total |                               |   |   | 100            |

### 5.3 Competition environment

The total area of the competition area is determined according to the number of participants. The headroom shall not be less than 3.5 m, with good lighting, lighting and ventilation. The ambient temperature and humidity shall comply with the equipment use regulations and meet the normal

competition requirements of the competitors.

#### 5.4 Training requirements

In order to ensure the quality of the competition and the absolute safety of the actual operation, all participants are recommended to participate in the training organized 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.

##### 5.4.1 Training time

Training duration is 5 days.

##### 5.4.2 Training contents

The training content is as follows:

- a) Reverse modeling software operations and case studies;
- b) 3D scanning and data detection;
- c) Processing and innovation design of 3D scanning point cloud;
- d) 3D modeling software operations and case studies;
- e) Lightweight analysis software operation and case analysis;
- f) Case analysis of product motion simulation design;
- g) Integrated 3D printing design and case analysis;
- h) 3D Print forming and post-treatment;
- i) CNC programming and operation.

##### 5.4.3 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.

#### 5.5 Participants

##### 5.5.1 Requirements for age

Over 16 years of age and under 60 years of age without gender restrictions.

##### 5.5.2 Group mode

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

### 6 Competition content

#### 6.1 Competition task

The industrial design technology competition is composed of six modules, including: core component modeling; design of special parts; innovative design of mechanism; product function realization; fast production of prototype; manufacturing challenge: comprehensively examine the product design and the combined processing capacity of added and reduced materials of the participants.

##### 6.1.1 Module A core component modeling

It refers to the three-dimensional scanning of a product part with a given scanner to obtain the point cloud data of the part shape. The player conducts data processing and three-dimensional digital reverse modeling. The manufactured CAD model shall eliminate the original object defects caused during production, operation, failure and maintenance (nick, burr, welding, brazing, chip, etc.), and restore the original geometry as the key point of evaluation.

Complete the digital model of the specified part of the product according to the two-dimensional engineering drawing (two-dimensional part drawing and two-dimensional assembly drawing) of the product parts (except for the given three-dimensional model parts) with the drawing software specified by the competition organizing committee, and complete the virtual assembly of the product in combination with the reverse modeling parts. The

key points of the evaluation are the digital model of the parts and the virtual assembly model.

### 6.1.2 Module B special part design

Design special parts meeting the assembly relationship and function realization according to the assembly relationship in the virtual assembly body of the product in task 1, determine the material, appearance and other characteristics of the special parts according to the given scenario or task requirements, carry out structural statics finite element analysis, verify whether the stress meets the requirements, and prepare the finite element analysis report; generate 2D engineering drawings of special parts; complete the overall assembly of the product, configure scene style and light source style, generate rendering images, generate assembly or disassembly animation, and generate 2D assembly drawings of the product. Special engineering drawings and stress analysis are the key points for evaluation.

### 6.1.3 Module C mechanism innovative design

According to the equipment requirements, a group of mechanisms are designed to achieve the expected functions; carry out lightweight analysis and optimization of parts to meet the requirements of weight and safety factor; prepare product innovation design report;

### 6.1.4 Module D product function realization

Complete virtual assembly; exploded view and assembly animation; make animation of working principle. Assessment focuses on realization of expected functions and lightweight of parts.

### 6.1.5 Module E fast production of prototype

According to the contest requirements, given models and drawings, 3D models are constructed with 3D software. Slicing software can be used for slice processing, reasonable parameters can be set, and 3D printing program can be output. Slice files can be imported into the 3D printer, operated according to the printer instructions, post-processed, support structure removed, 3D printing completed, part detection, surface quality detection, defect detection, etc. Submit the product, judge and inspect the dimensional accuracy and quality of the product, and save all documents in the correct format and path specified in the task.

### 6.1.6 Module F manufacturing challenge

Design tooling fixtures and conduct 3D printing according to the dimensional accuracy requirements of given work blank and parts; Then, use the fabricated fixture to clamp the part blank, reasonably arrange the processing technology, process the key surface of the part matching in the way of material reduction processing, and conduct precision inspection.

## 6.2 Specific gravity

Competition module and the specific gravity see table 2.

**Table 2 Competition module and the specific gravity**

| Module | Competition Contest              | Percentage (%) |
|--------|----------------------------------|----------------|
| A      | Core Component Modeling          | 10             |
| B      | Design of special parts          | 20             |
| C      | Innovative design of mechanism   | 20             |
| D      | Realization of product functions | 15             |
| E      | Rapid production of prototype    | 10             |
| F      | Manufacturing challenges         | 20             |
| G      | Work organization and management | 5              |
|        | Total                            | 100            |

### 6.3 Duration of competition

The competition duration can see table 3.

**Table 3 The competition duration**

| Module                                     | Duration ( min ) |
|--|------------------|
| Module A: Core component modeling          | 90               |
| Module B: Design of special parts          | 120              |
| Module C: Innovative design of mechanism   | 150              |
| Module D: Realization of product functions | 120              |
| Module E: Rapid production of prototype    | 120              |
| Module F: Manufacturing challenges         | 180              |
| Total                                      | 780              |

### 6.4 Project task release

The test questions, evaluation standards and scanned samples are confidential and will not be disclosed. However, the technical working documents of the competition, competition samples and relevant facilities, equipment, tools, etc. shall be published on the website designated by the technical working committee of the competition before the competition.

The open competition sample questions shall be officially announced no later than 15 days before the competition, and the official competition information platform shall release the competition sample questions to the participants.

### 6.5 Confidentiality requirements

"Confidentiality Requirements" section should elaborate on how confidentiality is ensured during processes such as volume grouping, printing, sealing of examination papers, and unsealing of examination papers.

## 7 Scoring standard

### 7.1 Evaluation Score

Assessment scoring method: judges score separately, and the difference between judges must be less than or equal to 1 point.

Judges are evaluated in four levels 0-3. Such assessment is used to make subjective judgment on the quality of the assessment object, and 3 experts are required to participate in the assessment. Each expert makes his or her own assessment, in which case the difference between the expert ratings shall not exceed 1 point. If more than 1 point is given, the assessment is invalid and the judgement shall consult as appropriate. The weight table is shown in table 4.

**Table 4 Weight and weight of evaluation**

| Weight Score | Description of requirements  |
|--------------|--|
| 0            | In all respects below industry standards, including "no attempt" or unacceptable |
| 1            | Meet industry standards  |
| 2            | Meet industry standards and in some respects exceed standards                    |
| 3            | Excellent level expected by the industry, perfect                                |

### 7.2 Measurement points

Measurement scoring method: all judges discuss together and give only one score after reaching an agreement on the actual score of the player in this item. See table 5 for an example of measurement score.

**Table 5 Example of objective scoring**

| Type                   | Example   | Maximum 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               |
| Deduct from full score | There are 10 marked dimensions in an engineering drawing, with the maximum score of 2 points; deduct 0.2 point if one dimension fails to meet the requirements, and deduct 4 points if the other dimension fails to meet the requirements | 2             | 1.2           | 0.8             |
| Increment from zero    | 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               |

### 7.3 Evaluation and measurement score distribution

The application table of evaluation score (subjective) and measurement score (objective) contains general information for formulating scoring scheme and competition items. See table 6 for specific score distribution.

**Table 6 Score distribution of evaluation and measurement evaluation of each module**

| Module | Project Task                     | Evaluation Score | Measurement Score | Total |
|--------|----------------------------------|------------------|-------------------|-------|
| A      | Core component modeling          | 1                | 9                 | 10    |
| B      | Design of special parts          | 4                | 16                | 20    |
| C      | Innovative design of mechanism   | 2                | 18                | 20    |
| D      | Realization of product functions | 3                | 12                | 15    |
| E      | Rapid production of prototype    | 2                | 8                 | 10    |
| F      | Manufacturing challenges         | 4                | 16                | 20    |
| G      | Work organization and management | 5                | 0                 | 5     |
| Total  |                                  | 21               | 79                | 100   |

### 7.4 Scores ranking

The ranking rules for scores are as follows.

- The one with higher total score ranks first;
- If the total score is the same, the module with higher score shall rank first according to the order of module C, module D, module B, module A, module F and module E.

### 7.5 Result release

The chief expert shall be responsible for the preparation of competition documents, venue management and score evaluation. After the score is completed and signed by the judges, the chief expert shall confirm it and submit it to the competition organizing committee for unified publication.

### 7.6 Awards setting

### 7.6.1 Certificates

The winning/excellent teams will be granted a certificate of award issued by the BRICS Business Council.

### 7.6.2 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; certificates issued by other participants.

### 7.6.3 Other awards

Designs meeting the needs of multiple national markets or using standardized parts designed by contestants from other countries will be awarded the "BRICS Collaboration Award". 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.

## 7.7 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 (work piece) of the participants, summarize the skill highlights and problems reflected in the competition process, and put forward opinions and suggestions.

## 8 Responsibilities of adjudicators, leaders and translators

### 8.1 Responsibilities of chief expert

#### 8.1.1 Setup and roles

The chief expert is the top person in charge of the judging team, one of whom is mainly responsible for the overall guidance and supervision of the judging activities of the events. After the competition, organize the technical summary and technical review of the project.

#### 8.1.2 Formulation and approval of rules

Organize the preparation of contest questions and evaluation standards before the competition, and review and confirm the final contest questions and evaluation standards.

#### 8.1.3 Dispute resolution

In case of any judgement dispute during the game, the chief expert shall intervene immediately to ensure that the problem can be solved fairly and quickly.

#### 8.1.4 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.

### 8.2 Responsibilities of deputy chief expert

#### 8.2.1 Setup and assistance

One deputy chief expert is appointed to assist the chief expert and jointly ensure the efficient operation of

judgment.

### **8.2.2 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.

### **8.2.3 Daily work**

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

## **8.3 Responsibilities of judges**

### **8.3.1 Team composition**

In principle, each team is required to appoint one umpire to participate in the field and scoring execution of events, pre-competition training and technical discussion, and master the technical rules of competition.

### **8.3.2 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. Obey the work arrangement of the chief expert and do a good job in his/her own work; carry out the arbitration in a fair and just manner without favoritism and fraud; stick to the post, strictly abide by the time arrangement of enforcement, and ensure the normal implementation of enforcement.

### **8.3.3 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.

## **8.4 Leader's responsibilities**

### **8.4.1 Setup**

One leader for each team.

### **8.4.2 Responsibilities**

The team leader is responsible for the daily management and discipline maintenance of each team to ensure that the teams abide by the game rules and order. As the contact between the team and the judging board, assist in conveying information and answering questions about the game rules.

## **8.5 Translation responsibilities**

### **8.5.1 Setup**

Interpreter per team.

### **8.5.2 Responsibility**

Translators provide multilingual translation services to ensure that there are no barriers to communication between teams, judges and staff from non-native countries. Facilitates cross-cultural understanding, ensures accurate information in the judgment process, and reduces misunderstanding due to language differences.

## **9 Selection and generation of judges**

The chief expert is generated by direct transfer and selection. Chief experts to be selected shall be selected by the organizing committee according to the selection conditions and work scheme.

The deputy chief expert shall be nominated by the chief expert to the organizing committee for approval and filing. The chief expert and deputy chief expert will be finally announced by the organizing committee.

In principle, one umpire is recommended for each team. If the number of judges fails to meet the needs of the work, the chief judge shall propose an application for increasing the number of judges no later than 6-8 weeks before the game. After discussion by all judges and approval by more than 2/3, the application shall be submitted to the executive committee for review and to the organizing committee for approval.

## **10 Judge management**

### **10.1 Training**

#### **10.1.1 Training contents**

The latest development trend of industrial design technology, international judgment criterion, judgment system operation, ethics and crisis management, etc.

#### **10.1.2 Training mode**

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

#### **10.1.3 Examination 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.

### **10.2 Evaluation**

#### **10.2.1 Evaluation period**

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

#### **10.2.2 Evaluation method**

At the end of the game, under the guidance of the organizing committee, organize staff, judges and other personnel to evaluate the work of the chief expert in real name through online mode. The chief expert assesses the work of the deputy chief expert and the judges.

#### **10.2.3 Application of results**

The evaluation is carried out according to three grades: A (excellent), B (ordinary) and C (poor). 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.

## **11 Technical platform**

### **11.1 Software platform**

#### **11.1.1 Operating system**

Win 10 64 bit Astra Linux, Linux\_Mint, Hongmeng PC, etc.

#### **11.1.2 Text processing software**

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

#### **11.1.3 Digital design and manufacturing software**

Main functions: 3D modeling, surface design, 2D and 3D data exchange, 3D data compatibility, parameterized design, standardized part library, digitalized design case library, professional design tools (metal plate and welding), 3D pipeline design tools, 2D drawing, rendering and visualization, motion simulation and stress analysis, lightweight design, NC processing code generation and reverse engineering. Use software such as auto CAD developer professional and auto CAD fuse 360.

#### 11.1.4 Cooperative design software

Main functions: data management, team management, collaborative design review, user operation, independent geometric modeling engine compatible with international mainstream geometric modeling engine. Use software such as Crown CAD.

### 11.2 Hardware name and technical parameters

#### 11.2.1 Computer

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

#### 11.2.2 Reverse design data acquisition equipment

Equipment meeting the following technical parameters or more advanced:

- a) Color texture: support 24 true colors;
- b) Integrated magnetic holder ensures the turntable and scan head are firmly integrated. Only one calibration is required, no subsequent repeated calibration is required, and no manual adjustment of bracket positioning is required. Anti-shake stable scanning effect);
- c) Scanner camera: 2 color cameras equal to or greater than 3 million pixels;
- d) Scanning mode: turntable full-automatic scanning and free scanning;
- e) Scanning range: turntable full-automatic scanning: no less than  $220 \times 220 \times 210$  mm; free scanning: no less than  $740 \times 740 \times 740$  mm;
- f) Scanning speed: turntable full-automatic scanning:  $\leq$  2 min; Free scanning:  $< 6$  s (single amplitude);
- g) Splicing mode: automatic splicing of turntable, marking point splicing, manual splicing and feature splicing;
- h) Scanning accuracy: volume accuracy  $\leq$  0.1 mm;
- i) Output format: STL, ASC, OBJ, PLY, VTX, OFF、FB;
- j) Whether the output data can be directly printed: without the help of third-party software, directly output the complete STL model for 3D printing;
- k) Multi-interface intelligent turntable: the intelligent turntable can not only cooperate with the 3D scanner for full-automatic scanning, but also can be independently controlled by the software for research such as object shooting or 3D modeling of photos;
- l) One click 3D printing: The software has a one click printing button and built-in slicing software for layering and post-processing, without the need for format conversion. The scanned STL data can be directly imported into the layering software through shortcut buttons for layering processing, generating layering files for the corresponding model.

#### 11.2.3 Equipment of additive and subtractive manufacturing

##### 11.2.3.1 Additive manufacturing equipment

Equipment meeting the following technical parameters or more advanced:

- a) Fabrication size: not less than  $300 \text{ mm} \times 300 \text{ mm} \times 300 \text{ mm}$ ;
- b) Slice control: including interactive editing system, which can realize the production of complex works;
- c) Maximum speed: no less than 80 mm/s;
- d) Minimum layer thickness: no more than 0.05 mm;
- e) Material: PLA, ABS;
- f) Data transmission: support USB and other data transmission modes.

##### 11.2.3.2 Subtractive manufacturing equipment

Equipment meeting the following technical parameters or more advanced:

- a) Stroke: transverse (X-axis), longitudinal (Y-axis) and vertical (Z-axis) strokes shall not be less than 200 mm, 90 mm and 200 mm respectively;
- b) Repeated positioning accuracy: the error is not more than 0.02 mm;

- c) Maximum spindle speed: no less than 3500 r/min;
- d) Maximum milling diameter: not less than 60 mm;
- e) Maximum borehole diameter: not less than 16 mm;
- f) Safety protection: comply with IP54 requirements, fully enclosed structure, with automatic switch device of safety protection door and internal lighting;
- g) System: implement international general standard G code programming, support M code and S code;
- h) Data transmission: support USB and other data transmission modes;
- i) Communication function: support Modbus communication protocol and MES system communication with network port.

## 12 Site

### 12.1 Site environment

Reasonably select the competition site according to the number of participants. Each player's workstation is required to be no less than 8 square meters. The site shall be provided with good lighting, lighting and ventilation. The ambient temperature and humidity are suitable, and the height is not less than 3.5m. Reasonable power supply and network system, and emergency power supply. Power shall be greater than 1500 watts.

### 12.2 Site layout

The competition area, working area and observation area are set in the competition field. The competition area consists of the examination area, waiting area and competition position area. The working area includes the infirmary and security room of the supervision arbitration and arbitration offices. The viewing area is separated by partition and competition area. More than 2m observation channel can be set. The venue can be observed without disturbing the game. Rest areas for leaders and instructors shall be set in other areas according to the conditions of the organizer, with a certain distance from the competition area. The station layout is shown in figure 1.



**Figure 1 Layout of workstation**

### 12.3 Site management

The management of competition venues must comply with the following requirements.

- a) Warning lines and safety areas shall be set around the competition site 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 work piece (results), tools, materials, etc. of each station, and uniformly arrange the demobilization.
- d) For equipment requiring initialization and parameter restoration, the chief judge shall handle it with experts and judges to ensure the consistency of competition environment.

## **13 Competition 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 competition venue must have the following safety facilities:

- a) The equipment and devices in the arena comply with regulations, and construction is strictly carried out in accordance with safety standards, leaving no hidden dangers. Organize relevant personnel to conduct safety hazard inspections before the competition;
- b) The venue is equipped with complete fire extinguishing and emergency facilities. Post evacuation signs in prominent locations;
- c) Security screening equipment should be installed at the entrance of the competition area, and it is prohibited to carry any items other than competition supplies;
- d) The safety operating procedures for competition equipment should be posted on the competition venue, and players should be informed before the competition;
- e) The competition venue must be equipped with corresponding medical and emergency personnel, as well as emergency rescue facilities and contingency plans.

### **13.3 Management and restriction of toxic and harmful substances**

The management and restriction requirements for toxic and harmful substances on the competition site are as follows:

- a) Prohibit athletes and all participants from bringing any toxic or harmful substances into the competition venue;
- b) Chemicals used in competitions must be accompanied by safety operating instructions. When using hazardous chemicals, it is necessary to wear protective clothing that complies with relevant regulations, A-type disposable gloves, safety goggles, respirators and other safety protective equipment, and operate in a standardized manner.

### **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.

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