



2024

BRICS SKILLS COMPETITION

(BRICS FUTURE SKILLS & TECHNOLOGY CHALLENGE)

COLLABORATIVE ROBOT

BRICS-FS-30

Technical Description

(International Final)

July, 2024



Catalogue

- 1. Introduction 1
 - 1.1 Name and description of the skill competition 1
 - 1.2 Relevance and importance of this document 1
- 2. Skills standard2
 - 2.1 General description of the skill standards2
 - 2.2 Skill standards3
- 3. Scoring scheme 8
 - 3.1 Scoring method8
 - 3.2 Scoring rules 8
 - 3.3 Evaluation basis 8
- 4. Test project9
 - 4.1 Common precautions 9
 - 4.2 Test the project format / framework 9
 - 4.3 Time allocation and score weight of test items9
 - 4.4 Operation contents and requirements of each module9
 - 4.5 Announcement of test items11
 - 4.6 Changes of the test items 11
- 5. Skill management and communication 11
 - 5.1 Expert panel 11
 - 5.2 Discussion group 11
- 6. Safety requirements 11
 - 6.1 Event safety management 11
 - 6.2 Safety management of the competition environment 11
- 7. Materials and equipment 12
 - 7.1 List of infrastructure 12
 - 7.2 Entry contestant's tool kit 12
 - 7.3 Materials and equipment prohibited in the skill area 12
 - 7.4 Recommended competition area and workstation layout 13
- 8. Skill-specific rules 13

1 Introduction

1.1 Name and description of the skill competition

1.1.1 Name of the skill competition

Collaborative robot

1.1.2 Description of the skill competition

The brics vocational skills competition collaboration robot item offline competition organization based on collaborative robot technology and application of comprehensive training platform competition platform, by the digital twin module, trajectory drawing module, assembly motor module, collaborative robot under the tetris module, players need through PLC, HMI, collaborative robot, visual detection unit, artificial intelligence algorithm unit complete offline homework assessment, collaborative robot offline competition is a team skills competition, each team has two players.

The application skills of collaborative robot technology include several aspects: robotics technology, mechatronics technology, electrical automation technology, mechanical manufacturing technology, computer foundation, robot vision technology, digital twin technology, etc.

Collaborative robotics application professionals need to have the following job skills:

(1) Robotics technology

Safe operation specification of cooperative robot, structure of cooperative robot, kinematics and dynamics of cooperative robot and AC servo motor drive, control of cooperative robot, structure and control of mobile transportation system, approach of cooperative robot, and vision sensor.

(2) Mechatronics

Electromechanical integration development situation, mechanical parts selection and application, selection and application of execution parts, the control system and application, common sensor control principle and application, common electrical control principle and application, information technology, microelectronics technology application, signal transformation technology application, and limit and coordination, belt transmission and chain transmission, gradual gear transmission, fixed shaft system, commonly used mechanism, bearing, connection, hydraulic and pneumatic foundation, etc.

(3) Electrical automation

Basic knowledge and basic skills, electrical design related safety standards and specifications, the basic theory of electrical engineering. Including electrical foundation and electrical measurement two parts, the key for electrical foundation, including dc circuit, electromagnetism, ac circuit, the sinusoidal circuit and transition process basic concept, the basic structure principle and usage, sensor and detection technology application, automatic

control principle and application, power electronic technology application, power drag technology application and digital circuit and analog circuit theory basic content.

(4) Mechanical manufacturing

Related standards and specifications of mechanical design, basic theory of projection geometry and basic knowledge of drawing, drawing method of machining parts drawing and assembly drawing, national standard of engineering drawing, size tolerance, and annotation of surface roughness. Material properties, test methods and their selection. Heat treatment method and selection of common metal materials. Basic knowledge and skills of mechanical product design design of parts, mechanical manufacturing process specification design, commonly used parts mechanical processing methods, equipment and advanced manufacturing technology. Formulate the basic knowledge and skills of the process, and formulate the processing process of typical parts.

(5) Computer foundation, machine vision

Basic knowledge of computer language, calibration of visual system, tuning parameters, point cloud processing, etc

(6) Digital twinning

Production process planning, production layout, production process simulation, virtual and real combination, production efficiency and output optimization, process monitoring, diagnosis and maintenance, digital twin and industrial Internet and manufacturing big data and other related content.

1.2 Relevance and importance of this document

This document contains information on the criteria required for the skills competition, as well as the evaluation principles, methods and procedures for managing the competition.

Each expert and contestant must understand and understand this technical description.

In case of any conflict between the technical instructions of the different languages, the English version shall prevail.

2 Skills standard

2.1 General description of the skill standards

Skills standards define knowledge, understanding, and specific skills that are best international practices in technical and professional performance. It will reflect a global global consensus on what relevant job roles or professions are represented in industry and business.

A skill competition reflects the international best practice described by the skill standard and the extent to which it can achieve. Therefore, the standard is a guide to the training and preparation required for skills competitions.

The standard is divided into different sections with the title and the reference numbers.

Each fraction was assigned a percentage of the total score to indicate its relative importance in the criteria. This is often referred to as "weights". The sum score for all percentages was 100. The weights determine the allocation of the scores in the scoring criteria.

By testing the items, the scoring scheme only evaluates the skills listed in the standard. They will reflect the standards as fully as possible under the constraints of the skills competition.

The scoring scheme will be within the actual possible range to the scores assigned in the criteria. A 5% change is allowed, but the weight assigned by the standard specification shall not be changed.

2.2 Skill standards

part		relative materiality (%)
1	Work organization and management	5
	<p>The players need to understand and understand:</p> <ul style="list-style-type: none"> – Principles and methods for the execution of safety work; – Use, use, maintenance and maintenance of all equipment and materials and their impact on safety; – Environmental and safety principles and their application to good housekeeping management; – Principles and methods of work organization, control and management; – Principles of communication and cooperation; – The scope and limitations of the roles, responsibilities and obligations of the player and others, alone or collectively; – Parameters to be followed when planning the activities; – Principles and techniques of time management. 	
	<p>Players should be able to:</p> <ul style="list-style-type: none"> – Prepare and maintain a safe, clean and efficient work area; – Prepare for the task at hand, including full consideration of OHS; – Arrange work to maximize efficiency and reduce schedule disruption; – Apply (or exceed) OSH standards related to the environment, equipment and materials; – Return the working area to the appropriate state; 	

	<ul style="list-style-type: none"> – Contribute to teamwork and organizational performance in both overall and specific aspects; – Provided and received feedback and support. 	
2	communication skill	5
	<p>The players need to understand and understand:</p> <ul style="list-style-type: none"> – Organizational culture and industry practices within the enterprise and the industry; – Purpose and scope of the required documents submitted in paper and electronic form; – Technical terms related to the occupation and the department; – Standards required for regular and special reports in oral, written and electronic form; 	
	<p>Players should be able to:</p> <ul style="list-style-type: none"> – Interact with various businesses and behaviors, and learn professional norms at any time; – Communicate orally, written and electronically to ensure clarity, effectiveness and efficiency; – Use of standard communication skills; – Read, understand, and extract technical data and instructions from documents in any available form; 	
3	Layout and design	10
	<p>The players need to understand and understand:</p> <ul style="list-style-type: none"> – Principles and related applications of computer science and electronics; – Related practical application of engineering science and technology; – Related practical application of part drawing and assembly drawing; – The principle and related applications of electrical engineering and pneumatic engineering; – Design, use, repair and maintenance needs of related machinery and tools; – The principle and application of robots, robot tools and equipment installed on robots and robot units; 	
	<p>Players should be able to:</p> <ul style="list-style-type: none"> – Obtain and check instructions and instructions for the assigned tasks; 	

	<ul style="list-style-type: none"> – Identify and resolve the uncertainty regions in the profile parameters; – Preliminary system design for a given industrial application; – Check the installation site or use other methods to test the suitability of the initial system design; – Mechanical parts measurement and modeling, engineering drawing generation; – Determining the application of pneumatic elements in the selection and connection of control and drive devices; – Systematic analysis of risk assessment detailing the requirements and implications of associated installation and integration; – Robots, assistive devices, and tools – Estimate the impact on production during installation; 	
4	Installation and connection of the comprehensive practical training platform for collaborative robot technology and application	20
	<p>The players need to understand and understand:</p> <ul style="list-style-type: none"> – Receiving the norms and culture of the industrial sites; – Principles and methods for the safe receipt and continuous management of equipment, tools and materials; – Basic principles for the physical installation of robots in the production systems; – The principle and method of assembling and using the pre-machining robot at its position; – Principles and method of installing the delivery system at its position; – Basic principles of positioning, connection and use of pneumatic devices; – The basic principles of the foundation and fixation methods required for the installation of collaborative robots and peripherals; 	
	<p>Players should be able to:</p> <ul style="list-style-type: none"> – Check whether all products are delivered properly, and follow up as required; – Organize the safe storage of all articles, and arrange the entry and exit of articles; – Check the description document to connect to the cooperative robot system components; – Test during installation to ensure complete functionality; 	
5	Collaborative robot technology and application of the comprehensive training platform for automatic debugging and programming	40

	<p>The players need to understand and understand:</p> <ul style="list-style-type: none"> – Computer ability and symbolic logic; – Manage the purpose and function of the computer hardware and software; – Control the cooperative robot coordinate system, and calibrate it with the cooperative robot, components and tools; – Control the cooperative robot motion; – Implement reprogramming and adjustment; – Provide principles, reasons and methods for splitting information or data; – How to use various software tools to develop and improve the model; – How to use visual software to obtain image data; 	
	<p>Players should be able to:</p> <ul style="list-style-type: none"> – Negotiate with customers and other personnel to clarify the project intention; – Write, analyze, events and optimize procedures using flow charts and icons; – Create application software programs that are easy to record, understand, and maintain; – Write changes and maintain computer programs or software packages to handle specific work; – According to the provided model, build the 3-dimensional simulation animation of the competition platform; – Communication with collaborative robots through PLC; – Communicate with collaborative robots through visual software; 	
6	Equipment maintenance and fault inspection and troubleshooting	15
	<p>The players need to understand and understand:</p> <ul style="list-style-type: none"> – Formal requirements for a successful site acceptance test; – Scope and limitation of technical methods and operating environment; – Standard method for testing the equipment and systems; – Failure finding, problem solving, and optimization strategies; – Principles and techniques for producing creative and innovative solutions; – Resumes and the principles of maintaining the production system; 	
	<p>Players should be able to:</p>	

	<ul style="list-style-type: none"> – Check whether the cooperative robot and the peripheral equipment are operating normally according to the procedure; – Modify, optimize, or extend existing programs to improve operational efficiency or use new requirements; – Developing human-machine interface (HMI) applications for the collaborative robot platform using WINCC or other WEB technologies; 	
7	Documents and reports	5
	<p>The players need to understand and understand:</p> <ul style="list-style-type: none"> – The content composition of the user document; – Format specification of the user document; – The operation method of office software; – Maintain the role and importance of records at each stage of the activity, the necessary media and format for recording and reporting, and laws for verification and audit. Information, guidance, and instructions presented in the appropriate form (media, content, language, format, and presentation). Specific information needs of customers, basic principles and techniques for introducing and training non-professional end users. 	
	<p>Players should be able to:</p> <ul style="list-style-type: none"> – Communicate with customers to understand their needs; – Analyze the usage scenarios and permission range of different user roles; – Combing out the operation process of different roles of users; – Conceive the content to present the technical document, and organize the technical language, so as to make the technical document clear and easy to use. – Contact with other personnel or departments for project integration. Development documents were designed as needed, and notes for writing programs and subsequent revisions were inserted in the coding instructions so that others could understand the computer program. Provide test results during commissioning. Help and guide end users to make the technical documentation clear and easy to use. 	

3 Scoring scheme

3.1 Scoring method

The scoring of this competition will be scored by the referee team offline. If the player
BRICS-FS-30 Collaborative Robot_Technical Description

cheer other violations during the competition, the referee will deal with it according to the violation of the player, and if the case is serious, the result will be cancelled.

3.2 Scoring rules

1. The one with the high overall score is ranked first;
2. For those with the same total score, according to the order of module B, module C and A, the one with the highest module score will be ranked first.

According to the above two rules cannot be discharged, the cumulative competition time short ranking in the top.

3.3 Evaluation basis

During the competition design process, the choice of criteria and evaluation methods will be determined through the scoring scheme and test items.

Evaluation basis, including but not limited to:

- The integrity and specification of the operation process
- The integrity and specification of the work record card
- The correctness of the index calculation process, the correctness and standardization of the code
- Normalization of electrical installation and commissioning
- Collaborative robot technology and application of comprehensive training platform application proficiency
- Process, integrity, and correctness of the component assembly
- Results of the troubleshooting

4 Test project

4.1 Common precautions

Whether a single module or a series of independent or associated modules, the test item can evaluate the application of knowledge, skills and behavior defined in the standard (Skill Specification).

Combined with the scoring scheme, the purpose of the test project is to provide comprehensive, balanced and real opportunities for standard evaluation and scoring. The relationship between the test items and the scoring scheme and the criteria will be a key indicator of quality, as is the relationship between the criteria and actual work performance.

The test items did not include aspects other than the criteria and did not affect the balance of scores within the criteria.

The evaluation of knowledge and understanding is only through its application in
BRICS-FS-30 Collaborative Robot_Technical Description

practical work.

4.2 Test the project format / framework

The test item is composed of four relatively independent and connected modules:

Module A: Mechanical assembly and cooperative robot pattern drawing

Module B: The cooperative robot assembles small motors before handling and palletizing

Module C: Cooperative robot with visual Tetris

4.3 Time allocation and score weight of test items

module	duration (min)	Score value weight (%)
Module A: Mechanical assembly and cooperative robot pattern drawing	240	20
Module B: The cooperative robot assembles small motors before handling and palletizing	240	45
Module C: Cooperative robot with visual Tetris	240	30
Module D: Professional quality		5
amount to	720	100

4.4 Operation contents and requirements of each module

The content of the competition covers mechanical installation, collaborative robot pattern drawing, small motor handling, assembly, palletizing, 2D vision system, 3D vision and other contents, and comprehensively examines the application and engineering implementation ability of the comprehensive training platform of collaborative robot technology and application of the contestants.

Module A mechanical installation and cooperative robot pattern drawing: focus on the mechanical and electrical installation of positioning assembly mechanism, sensor detection and debugging, and basic trajectory teaching of cooperative robot;

Module B cooperative robot assembly small motor after handling, palletizing: based on BRICS-FS-30 Collaborative Robot_Technical Description

color sensor, pneumatic unit sorting, PLC programming, HMI writing, cooperative robot point teaching, grasping, handling, assembly, palletizing as the focus of the assessment;

Module C cooperative robot with visual Tetris: is the cooperative robot programming, visual and cooperative robot communication Settings, visual image point picking, visual master programming, artificial intelligence algorithm as the assessment focus;

Module D Professional quality: it is the focus of operation norms, professional ethics and team cooperation for electrical engineers and robot system integration engineers.

Module number	Module name	Scope of operation
A	Mechanical assembly and cooperative robot pattern drawing	<ol style="list-style-type: none"> 1 Install the positioning and assembly module 2 Draw the specified logo pattern
B	The cooperative robot assembled the small motor after handling the palletizing	<ol style="list-style-type: none"> 1 Make color sorting of small motor parts using a cooperative robot 2 Assemble the sorted motor components using a cooperative robot 3. Use a cooperative robot to handle and stack the finished motors
C	Collaborative robot with visual Tetris	<ol style="list-style-type: none"> 1 Use the cooperative robot to cooperate with 3D vision and 2D vision for one point vision, and make disorderly stacking of Russia square 2. Use cooperative robot with 2D vision to teach two point teaching with artificial intelligence algorithm under Tetris.

4.5 Announcement of test items

The test items will be posted via the website.

4.6 Changes of the test items

30% changes will be made before the official competition.

5. Skill management and communication

5.1 Expert panel

The skill expert group is composed of chief experts, deputy chief experts and expert members, who are responsible for further revising the technical documents of the remote final and daily skill management.

5.2 Discussion group

Participants with questions about hardware and software preparation and test environment deployment can enter the 2024 BRICS Vocational Skills Competition Collaborative Robot Competition group for feedback. The training and communication of this competition, before, during and after the competition will also be carried out through the group.

Online communication will be carried out using instant messaging tool Tencent conference, and the offline discussion forum will be held by the organizing committee.

6 Safety requirements

6.1 Event safety management

6.1.1. Competition equipment and facilities shall be constructed in strict accordance with the safety construction standards, and power wiring and electrical installation shall be constructed according to the specifications.

6.1.2. Arrange the fire extinguishers according to the fire safety requirements, and designate the responsible person to use them in an emergency.

6.1.3. The norms, regulations and qualification certificate requirements of national (or industrial) related vocational job safety are specified in the competition procedures.

6.1.4. The Executive Committee shall conduct safety training to all the referees and staff before the competition. According to the Labor Law of the People's Republic of China and other laws and regulations, a perfect safety accident prevention system shall be established, and the players shall be trained before the competition to avoid personal injury accidents.

6.1.5. The Executive Committee will establish a special plan to ensure the safety of the competition proposition, storage, distribution, recovery and evaluation process.

6.2 Safety management of the competition environment

6.2.1. The competition executive committee shall organize special personnel to inspect the competition site, accommodation place and traffic guarantee before the competition, and put forward clear requirements for safety work. The layout of the stadium, the equipment and equipment in the stadium shall comply with the relevant national safety regulations. And conduct the competition field simulation simulation test, in order to find out the possible problems.

6.2.2. A cordon shall be set up around the stadium, and security personnel shall not lend their documents to others to prevent irrelevant personnel from entering. Provide necessary labor protection for the players in the competition site according to the requirements of relevant professional positions. In the dangerous operation link, the referee should check and confirm that the equipment is normal before the competition, and strictly prevent the players from making mistakes during the competition.

7 Materials and equipment

7.1 List of infrastructure

The infrastructure list details all the equipment and facilities to be prepared by the participants, see the List of Offline Competition Infrastructure for the 2024 BRICS Vocational Skills Competition.

7.2 Entry contestant's tool kit

The participating tools shall be provided by technical support units. Do not use knives and tools with open blades to avoid damage (except for pneumatic hose cutter with jaw opening of 8 mm).

Recommended tools for performing tasks:

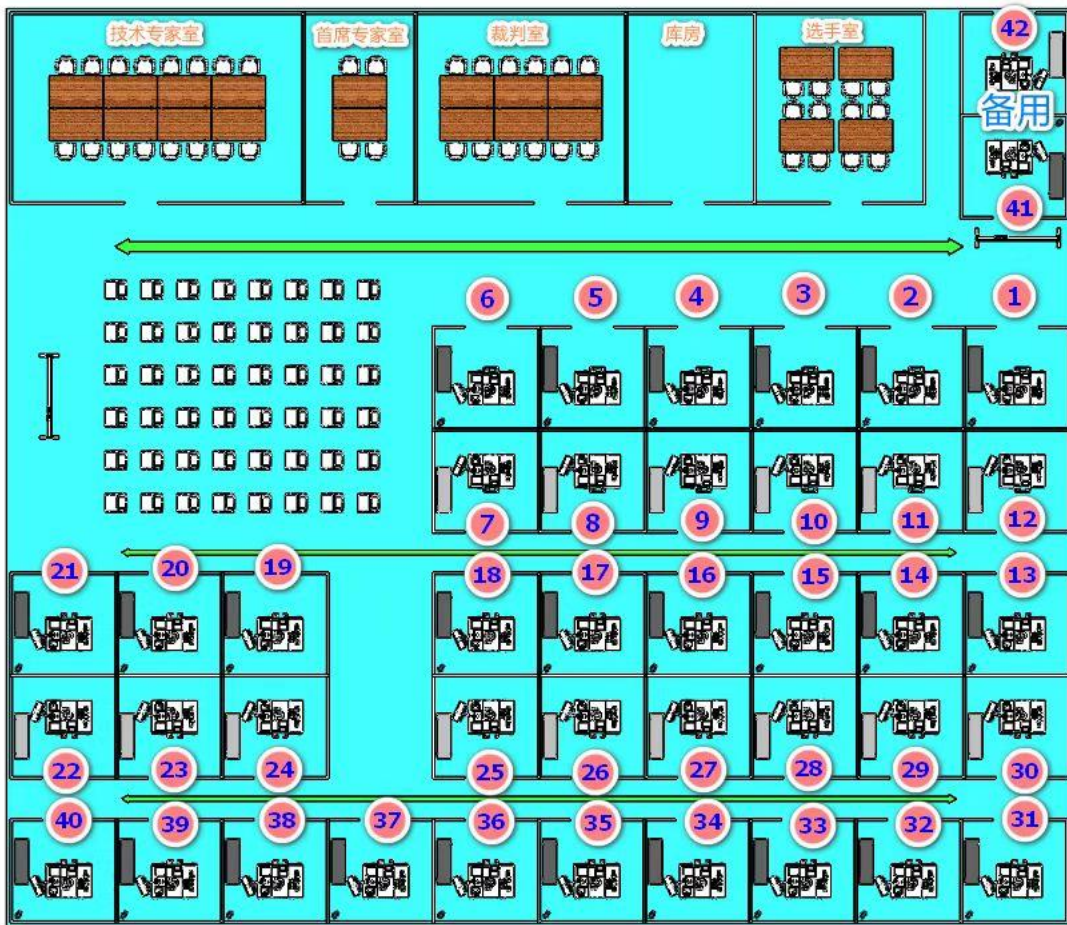
- Screwdriver (one-word, cross)
- connection cover cutting pliers
- Electrical inspection pen
- multimeter
- inner hexagon spanner
- band tape

The chief expert of the competition will announce it when other special tools are needed.

7.3 Materials and equipment prohibited in the skill area

Any materials and equipment carried by the participants shall be declared (presented) to the expert. Experts may prohibit the use of any item unrelated to the performance of the task or that may confer an unfair advantage on a competitor.

7.4 Recommended competition area and workstation layout



8 Skill-specific rules

Skills-specific rules cannot contradict or prioritize the rules of the game. They will provide specific details and clear explanations of the different aspects that vary by skill competition. They include, but are not limited to, personal computing devices, data storage devices, Internet access, work procedures, and document management and distribution.

Themes / Tasks	Skills-specific rules
Using the technology- -USB, memory stick	<ol style="list-style-type: none"> 1) Participants can only use the memory sticks provided by the competition organizers. 2) Do not bring memory cards or any other portable storage devices out of the arena. 3) Memory card or other portable storage device must be at the end of each day 4) Give it to the chief expert or deputy chief expert for safe storage.

2024 BRICS Skills Competition (BRICS Future Skills & Technology Challenge)

<p>Use technology: personal laptops, tablets, and mobile phones</p>	<ol style="list-style-type: none"> 1) Experts and interpreters can use personal laptops, tablets, and mobile phones. 2) Participants are not allowed to bring their personal laptops, tablets or mobile phones into the field.
<p>Using the technology- -a personal camera</p>	<p>Participants, experts and interpreters will have access to personal photo and video recording equipment in the workshop only after the test program is completed or with the consent of the lead expert.</p>
<p>Evaluation of the test items</p>	<ol style="list-style-type: none"> 1) For each workstation (module), the lead expert has the highest level of expertise in the field. As the participant completes the test program, the expert controls OHS compliance, completion or failure of the test program sites, which can only be assessed during the participant's completion of the task. The designated expert is fully responsible for the fairness of the contestant assessment. 2) If, on the workstation, the participant and the expert are from the same organization, the expert can be replaced once during the duration of the module.
<p>3Make 30%, of the change in the test items</p>	<p>During the introduction of 30% changes (on Day C-2), the expert must perform the following:</p> <p>According to the equipment and software provided by the competition sponsor (all modules):</p> <ul style="list-style-type: none"> -Update of the installed assembly drawing (or photo); -Update the electrical and pneumatic schematic diagram; -Update the point instructions on the device software and hardware features.
<p>The participants have had technical problems during the completion of the mission</p>	<ol style="list-style-type: none"> 1) If a technical problem occurs during the implementation of the test program (not due to the fault of the participant), the participant receives an additional time equal to the time from the discovery of the defect to the complete elimination of the defect. 2) If the technical problem is found to be caused by the contestant's fault, the contestant will receive no additional time.

BR
S

