BRICS 2022 CHINA

2022 BRICS Skills Competition

(BRICS Future Skills Challenge)

TECHNICAL DESCRIPTION

Industrial Digital Twin (Offline)

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1. INTRODUCTION

1.1. PROFESSIONAL SKILL NAME AND DESCRIPTION

1.1.1. PROFESSIONAL SKILLS NAME

Industrial Digital Twin

1.1.2. PROFESSIONAL SKILLS DESCRIPTION

The industrial digital twin project of the BRICS Skills Competition is based on the planning, implementation and optimization of digital factories. The main assessment contestants use simulation technology tools and digital twin platforms to build, operate and maintain digital twins. Complete tasks such as plant layout design, production line debugging, digital control and performance optimization of digital factories. At the same time, the 3D twin model is driven by the real-time data of the device running, so that the 3D twin model and the real device are kept in sync. In this way, the actual production state is highly simulated, and the specific production situation in the real environment is displayed in real time.

Industrial digital twin technology is a team skills competition with two competitors per team.

1.1.3 COMPETITION SYSTEM

The offline competition of the industrial digital twin competition takes the DLIR-257 industrial digital twin technology application system as the competition platform carrier.

Offline competitions provide competition reference documents and operation videos, as well as training and competition arrangements, results query, rankings and other information, which will be issued by the competition organizing committee.

1.2. RELEVANCE AND SIGNIFICANCE OF THIS DOCUMENT

This document contains information about the standards required to compete in the skill competition, and the principles, methods and procedures that govern the competition.

Each Expert and Competitor must know and understand this Technical Description.

In the event of any conflict between technical descriptions in different languages, the English version shall prevail.

2. STANDARDS SPECIFICATION

2.1. GENERAL NOTES ON STANDARDS SPECIFICATION

The Standards Specification determines the knowledge, understanding, and specific skills that determine international best practices in technical and vocational performance. It should reflect a shared global understanding of what the associated work role(s) or occupation(s) represent for industry and business.

The skill competition is intended to reflect international best practices as described by the STANDARDS SPECIFICATION and to the extent that they can be implemented. The STANDARDS SPECIFICATION is thus a guide to the necessary training and preparation for the skills competitions.

The STANDARDS SPECIFICATION is divided into distinct sections with headings and reference numbers added.

Each section is assigned a percentage of the total points to indicate its relative importance within the STANDARDS SPECIFICATION. This is often referred to as a "weight". The sum of all the percentage points is 100.Weights determine the distribution of points in the grading scale.

The Marking Scheme and the Test Project will assess only those skills that are set out in the STANDARDS SPECIFICATION. They must reflect the STANDARDS SPECIFICATION as comprehensively as possible within the constraints of the skills

competition.

The Marking Scheme and the Test Project will follow the allocation of marks within the STANDARDS SPECIFICATION to the extent practically possible. A variation of 5% is allowed, provided that this does not distort the weightings assigned by the STANDARDS SPECIFICATI.

2.2. SKILL SPECIFICATION

Section	Relative importance(%) (%)
1 **Work organization and management**	5
The Individual need to know and understand: • principles and methods of safe work execution; • the purposes, use, care, and maintenance of all equipment and materials together with their safety implications; • environmental and safety principles and their application to good housekeeping in the work booth; • principles and methods for work organization, control, and management; • principles of communication and collaboration; • the scope and limits of one's own and other's roles, responsibilities and duties, both individually and collectively; • parameters within which activities need to be planned; • principles and techniques for time management.	
The Individual shall be able to: • prepare and maintain a safe, tidy, and efficient work area; • prepare oneself for the tasks at hand, including full regard for OHS; • schedule work to maximize efficiency and minimize schedule disruption; • apply (or surpass) the OSH standards relative to the environment, equipment, and materials;	

- restore the work area to an appropriate condition;
- contribute to teamwork and organizational performance both in general and specifically;
- give and accept feedback and support.

2	**Digital Factory Design**	10

The individual needs to know and understand：

- basic concepts of digital factory
- basic requirements for building a virtual factory environment
- operational steps for building and running a digital twin
- methods for virtual commissioning of digital twins

The Individuals should be able to:

- complete the construction of the digital twin virtual factory twin
- complete the attribute parameter settings of each module and test run
- complete network communication between digital twin and PLC and HMI simulation software
- complete the online running test of robot offline simulation software and digital twin

3.	**Assembly, debugging, and programming of System**	30

The individual needs to know and understand:

- basic knowledge of electric systems and how motors work
- basic knowledge of network interconnection between actual PLC and digital factory production line
- methods to verify the operational stability of the physical production line of the digital factory
- PLC and man-machine interface operation method
- basic knowledge of the structure and function of industrial controllers
- PLC and HMI configuration principle, sequence of action flow between program

codes

- programming and debugging of industrial robots, loading parameters, and basic calibration methods

The individual shall be able to：

- complete the task of building a hardware model of the actual production line
- assemble the equipment according to the drawings and technical documents provided
- electrical and pneumatic distribution according to the control schematic
- install, adjust and commission mechanical, electronic and sensor systems
- complete on-site sensor data collection and monitoring
- complete the communication connection between the program code of the robot and the external control system
- create and process robot program modules
- complete the application of PLC-based control system, establish connection with PLC, configure and apply external automation mode

4. **Personalized custom production**	20

The Individual need to know and understand:

- application of network communication technology
- the working principle of MES of Manufacturing Execution System
- customized production process planning
- production process control
- database principle and application
- operation and maintenance of production process

The individual shall be able to：

- complete the communication between MES system and production line network
- complete production line data collection and monitoring

- monitor production process information
- statistical production and processing output and production efficiency information
- personalized customized production products
- real-time monitoring of production energy consumption information
- check the stability of the production line
- display preventive operation and maintenance information
- debug and run the production line stably to complete customized production

5 **Virtual and real joint debugging of digital factory**	20

The Individual need to know and understand：

- devices run real-time data-driven models
- the principle and method of setting the motion attribute parameters of twin bodies
- develop industrial equipment program development steps
- working principle of virtual-real combination and virtual-real linkage
- virtual and real data collection and communication methods
- industrial digital twin network communication data collection and monitoring
- network communication and commissioning
- hardware and peripherals that meet the physical requirements of the network

The individual shall be able to：

- connect the controller to the robotic assistance system
- collect real-time sensor data according to mission requirements
- write, analyze, review and rewrite programs
- conduct a trial run of the application to ensure the correctness of the program
- write or assist in the writing of instructions or instructions to guide end users
- check whether the network, workstation, system central processing unit or peripheral device responds to the program's instructions

6. **Digital Factory Optimization**	15

The individual needs to know and understand：

• production line control process technology and optimization space • reduced reaction and response times in production • reduce time and cost in production • collect, share and use information for continuous optimization • principles and methods of cost-benefit analysis • industrial equipment program development process • ways to improve operational efficiency and product quality	
The individual shall be able to： • complete energy saving and emission reduction, eliminate waste and reduce costs • complete personalized customized production to prevent overproduction • develop reasonable arrangements for inventory and storage methods • develop and eliminate unnecessary processes • complete the reduction of defective product rate and put an end to substandard products • make reasonable adjustments to transmission and movement speeds • develop optimized wait times • analyze and recommend optimized methods	
Total	100

3. MARKING SCHEME

3.1. MARKING METHODS

The scoring of this competition adopts the method of measuring and scoring, and several scoring groups are set up according to the tasks, and each group is composed of 3 or more judges.

All judges in each group discuss together, and finally give only one point value after reaching an agreement on the actual score of the competitors in this item.

If a competitor cheats or violates other rules during the competition, the referee will deal

with the violation according to the competitor's violation. If the circumstances are serious, the score will be cancelled.

3.2. MARKING RULES

1. The person with the highest total score will be ranked first;

2. If the total score is the same, the order of Module E, Module D, Module C, Module B, and Module A, and the module with the highest score will be ranked first. When the above two rules cannot be ranked, the competitor with the shortest cumulative game time will be ranked first.

3.3. ASSESSMENT BASIS

During the competition design process, the selection of criteria and evaluation methods will be determined through the scoring scheme and test items. Evaluation basis, including but not limited to:

- Integrity and standardization of the work process
- Accuracy of parameter adjustment such as device action and device status
- Whether the bolt tightening meets the standard torque requirements
- Workmanship, completeness and correctness of component assembly
- Troubleshooting of equipment or component defects
- Results of troubleshooting
- Personal protection situation

4. TEST PROJECT

4.1 COMMON PRECAUTIONS

Whether a single module or a series of independent or related modules, test items can evaluate the application of knowledge, skills and behaviors defined in the Standard (Skill Specification).

Combined with the scoring scheme, the purpose of the test items is to provide a comprehensive, balanced and realistic opportunity for evaluation and scoring against the criteria.

The relationship between test items and scoring schemes and standards will be a key indicator of quality, just as standards are related to actual job performance.

The test items do not include aspects outside the criteria and do not affect the balance of scoring within the criteria.

A test item's assessment of knowledge and understanding is solely through its application in real work.

4.2 TEST PROJECT FORMAT/FRAMEWORK

The test project is five modules:

- Module A: Digital Factory Design
- Module B: Line Assembly, Programming and Commissioning
- Module C: Customized Production
- Module D: virtual and real joint debugging of digital factory
- Module E: Digital Factory Optimization

4.3 TIME ALLOCATION AND SCORE WEIGHTING OF TEST PROJECT

Module	Time（min）	Score（%）
Module A: Digital Factory Design	120	10
Module B: Line Assembly, Programming and Commissioning	120	30
Module C: Personalized Custom Production	120	20
Module D: Virtual and Real Joint Commissioning of Digital Factory	150	20
Module E: Digital Factory Optimization	90	15
Professionalism		5
Total		
Total	600	100

4.4 CONTENTS AND REQUIREMENTS OF EACH MODULE WORK

The content of the competition covers work organization and management, digital factory design, production line assembly, programming and debugging, personalized customized production, digital factory virtual and real joint debugging, digital factory optimization, etc. The main assessment competitors use simulation technology tools and digital twin platforms to build, operate and maintain digital twins, and complete digital factory layout design, production line debugging, digital control and performance optimization.

Module A mainly evaluates the competitors to build a 3D twin model of a digital factory; set the model attribute parameters, and complete the comprehensive application ability of the production line function verification.

This module combines virtual PLC, industrial robot offline programming software and digital twin platform, and uses virtual debugging, adaptive optimization and digital simulation verification technology to complete the debugging optimization and function verification of the electromechanical transmission control part and the digital twin;

Module B mainly evaluates the competitors to build a physical model of the digital factory, complete the comprehensive application ability of the actual PLC and the network interconnection of the digital factory production line, debug and verify the operation stability of the physical production line of the digital factory, and complete the debugging optimization and functional verification of the electromechanical transmission control part;

Module C mainly assesses the competitors' comprehensive application ability of manufacturing execution system MES and digital factory network platform, using network communication technology, collecting data information, optimizing production process and rhythm, and completing personalized customized production tasks;

Module D mainly assesses the ability of the contestants to use digital twins and production physical platforms to complete the interconnection between digital factory twin data and actual production line data and information;

Module E mainly assesses the competitors' comprehensive application ability to complete the optimization of the production process and rhythm of the digital factory according to the technological process and rhythm requirements, and to improve the production efficiency and product quality.

Module No.	Module name	Work scope
A	Digital Factory Design	01Virtual scene model construction 02Each model parameter is established 03Signal configuration 04 Write the virtual device running process 05Virtual device process debugging
B	Line assembly, programming and debugging	01Production line installation 02Production line power test 03System configuration and function check 04 Write a robot program 05 Write the equipment operation process program 06Equipment process debugging 07 Collect digital factory data and information is correct 08Verify the stable operation of the physical production line of the digital factory 09Complete the network interconnection between the actual PLC and the digital factory production

		line
C	Personalized Custom Production	01MES system can read PLC data information 02MES system can read robot data 03Place orders through MES system 04MES system can store completed orders
D	Digital factory virtual and real Joint Debugging	01Network interconnection 02Data collection 03 Virtual and real linkage
E	Digital Factory Optimization	01 Improve production efficiency 02 Improve product quality

4.5 TEST PROJECT ANNOUNCEMENT

The test project will be announced through the website:

Test items are announced 15 days before the competition.

4.6 TEST PROEJCT CHANGES

Before the official competition, the test items will be changed by 30%. These changes will be made available to experts and competitors 2 days before the competition.

30% of the changes will be kept confidential and will not be announced to experts and competitors until 2 days before the match.

5. SKILL MANAGEMENT AND COMMUNICATION

5.1. EXPERT GROUP

The skill expert group is composed of a chief skill expert and experts selected from various countries, who are jointly responsible for further revision of the technical documents and daily skill management of the remote finals of this competition.

6. SAFETY REQUIREMENTS

Please refer to the following documentations for details.

7. MATERIALS AND EQUIPMENT

7.1. INFRASTRUCTURE LIST

The infrastructure list details all the equipment and facilities that the participants need to prepare, see "2022 BRICS Skills Competition Offline Competition - Industrial Digital Twin - Infrastructure Equipment List".

Practical tools competitors bring their own, the following is a list of recommended tools

Allen key	7 piece set
adjustable wrench	Small
Needle nose pliers	160mm
wire stripper	
Crimping Tool	
Diagonal pliers	160mm
Phillips screwdriver	5×75mm
Flat-blade screwdriver	5×75mm
Phillips screwdriver	3×75mm
Flat-blade screwdriver	3×75mm
clock screwdriver	
soldering iron	35W
solder wire	
Steel ruler	20cm

tracheal scissors	
rubber hammer	Small
Electrical tape	
marker pen	
Scissors	Middle
multimeter	digital

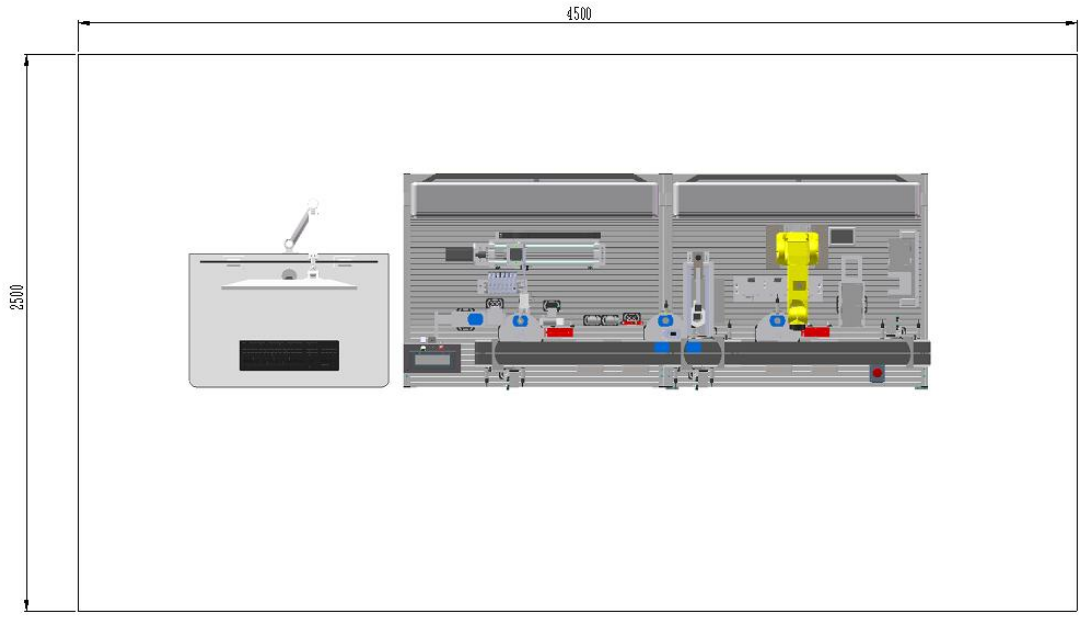
7.2. PROPOSED COMPETITION WORKSHOP LAYOUT

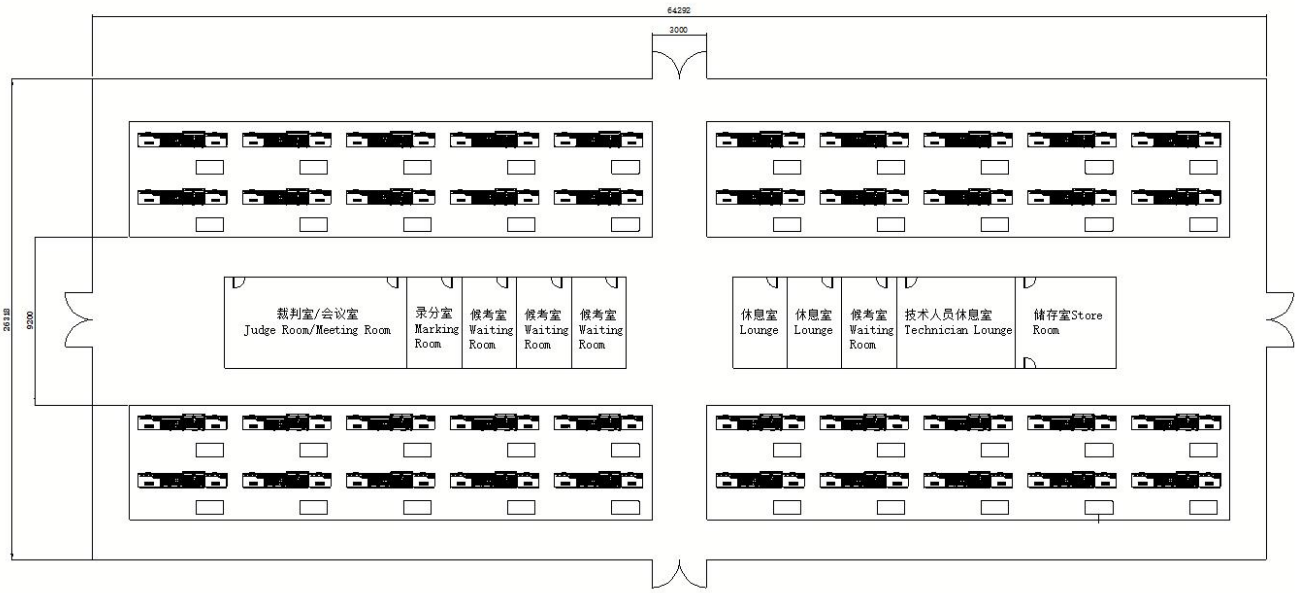
7.2.1. COMPETITION LAYOUT REQUIREMENTS

1. Competition workstations: Each workstation covers an area of 8 to 12 square meters, marked with the workstation number, and is equipped with 1 set of competition platform, 2 sets of computer desks and chairs, and notebooks (competitors bring their own).

2. Each station in the arena is provided with 220V single-phase three-wire AC power supply with independent control and leakage protection device and a gas source with a pressure of 0.6-0.8MPa. The computer power supply is supplied separately, and the power supply and gas supply system have necessary safety protection measures.

3. The site reference layout is shown in the figure.





Competition site layout (*see illustration*).