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Contents

Foreword

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Curriculum for industrial design technology competition

1 Scope

This document is applicable to vocational education, skills competitions, and training activities related to industrial design technology in BRICS countries, covering technical fields such as digital design, reverse engineering, and additive manufacturing.

This document is applicable to the organization and hosting of industrial design competition courses.

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
technical field of integrating design thinking, digital tools, and manufacturing technology to optimize product functionality, improve appearance, and innovate development

3.2
digital modeling
process of creating a 3D geometric model using CAD software, including sketching, parametric modeling, feature manipulation, and other steps, is used for digital design and manufacturing of products

3.3
parametric modeling
design method of controlling the geometric dimensions and features of a model by setting parameters is commonly used for rapid iteration and optimization of complex parts

3.4
reverse engineering
obtaining digital data of products through technologies such as 3D scanning and measurement, and based on this, modeling and optimization design are carried out for the improvement or redevelopment of product functions

3.5
additive manufacturing; AM
manufacturing technology of producing parts by stacking materials layer by layer, also known as 3D printing, is widely used in the manufacturing of complex shaped parts

3.6
subtractive manufacturing; SM
manufacturing technology of machining parts by removing materials through cutting, milling, or grinding

3.7
hybrid manufacturing
by combining additive manufacturing and subtractive manufacturing technologies, complex parts are manufactured by first additive molding and then subtractive precision machining

3.8
computerized numerical control; CNC
use of computer numerical control equipment for high-precision machining of parts is commonly used in subtractive manufacturing technology

3.9
3d scanning
using optical or contact scanning devices to obtain digital data of object surface geometry for reverse engineering or quality inspection

3.10
dynamic simulation
by simulating the motion process of a mechanical system, analyzing its kinematic and dynamic characteristics, it is used to verify the rationality and optimization performance of the design

3.11
stress analysis
using finite element analysis (FEA) method to calculate the stress distribution and deformation of mechanical parts under load, for optimization design

3.12
derivative design
process of redesigning existing products through structural adjustments, material improvements, or functional extensions to meet new requirements

3.13
3d routing
process of designing the optimal routing for equipment in three-dimensional space, ensuring the rationality and functionality of wiring

3.14
3d piping
design pipeline layout using 3D modeling tools, optimize the spatial distribution of pipelines, and ensure that they meet performance and safety requirements

3.15
international standards
technical specifications developed by the International Organization for Standardization (ISO) to ensure consistency in design, manufacturing, and quality control

3.16
skills passport
international skills certification issued by the BRICS Skills and Technology Standardization Committee proves the professional ability of students in the field of industrial design technology

3.17
quality control
according to standards such as ISO 9001:2015, the performance, size, and accuracy of products are tested and optimized during the design and manufacturing process

3.18
optimization design
through structural adjustment, material allocation, and process optimization, achieve a balance between product performance, weight, and cost

3.19
technical drawing
draw two-dimensional drawings of the product according to international standards to express the structure, dimensions, and process requirements of the product.

4 Curriculum overview

4.1 Typical work task description

There are three core fields in the industrial design technology competition: digital modeling expression and optimization of industrial design; reverse design and improvement; digital manufacturing of parts.

The detailed typical work tasks of digital modeling expression and optimization of industrial design are shown in table 1.

Table 1 Typical task description for digital modeling expression and optimization of industrial design

Typical work task name	Digital modeling expression and optimization of industrial design
Typical work task description	
The digital modeling and optimization of industrial design is a critical link in the field of industrial design. It integrates digital technology and design innovation, aiming to achieve high efficiency, accuracy and advancement of product design. With the continuous improvement of the requirements for digital design ability in the industrial field, there is an increasing need for talents who are skilled in digital modeling expression and optimization design. People with this capability not only build product models efficiently through digital means, but also optimize models to meet diverse design needs. The industrial designers receive the relevant work assignment from the supervisor, and explore the technical development thread and future trend in this field through in-depth research on the combination of typical cases related to industrial design digital modeling and modern cutting-edge digital modeling and optimization technology. Complete the following main tasks in order according to the requirements of the task book: a) Research on industrial design technology: 1) Compare the digital modeling expression and optimization cases of industrial design in different periods, and analyze the technical characteristics and advantages of each stage; 2) Research mainstream digital modeling software, tools and their application scenarios in the international market; 3) Evaluate the feasibility and development potential of different industrial design technologies based on market demands and industry development trends. b) Digital modeling of piston pneumatic motor: 1) Appropriate digital modeling software shall be selected according to the design requirements of piston pneumatic motor; 2) Three-dimensional digital model of piston pneumatic motor shall be constructed in strict accordance with relevant international standards (such as ISO 16792:2021); 3) During the modeling process, attention shall be paid to the geometric accuracy and details of the model to ensure that the model can accurately reflect the actual structure of the product. c) Intelligent optimal design of piston pneumatic motor bracket parts: 1) The part model of piston pneumatic motor support is analyzed to find the key parts that can be optimized; 2) The intelligent optimization algorithm and tools are used to optimize the geometric shape, dimension tolerance and other aspects of the support parts in combination with geometric product specifications such as ISO 1101:2017 and ISO 5459:2024; 3) The simulation test verifies the performance of the optimized support parts under different working conditions. d) Design expression of piston pneumatic motor: 1) Based on the technical drawing standards such as ISO 128:2022 and ISO 129-1:2018, the design expression scheme of piston pneumatic motor is formulated; 2) Use digital design tools to generate clear and accurate 2D design drawings, including different views, sectional drawings, etc; 3) Mark and explain the design drawings to ensure that the design intent can be accurately communicated. e) Efficient parameterization design of parts of piston pneumatic motor: 1) Parametric design model is established for some key parts of piston pneumatic motor; 2) Quick design change and optimization of parts are realized by adjusting parameters to improve design efficiency; 3) Ensure that the parametric design process conforms to relevant international standards and ensure the design quality. f) 3D wiring, piping and simulation analysis of an automatic production line: 1) In 3D CAD environment, an automatic production line is designed for wiring and piping; 2) Comply with ISO 10303:2024 (STEP standard), etc. to ensure rationality and compatibility of wiring and piping; 3) The simulation analysis tool is used to simulate the performance of the automatic production line after wiring and pipe laying, and analyze the performance of its operation stability, reliability, etc.	

Table 1 (*continued*)

Typical work task name			Digital modeling expression and optimization of industrial design
Typical work task description			
Upon completion of the above tasks, the final results shall be submitted to the supervisor for review and improvement through the project plan acquisition task stage, planning stage, implementation stage, evaluation and report stage and submission stage. Through these tasks, the digital modeling and optimization design ability of designers are comprehensively cultivated, so that their theoretical knowledge and practical ability can be systematically improved, laying a solid foundation for solving complex industrial design problems. Throughout the operation, international standards such as ISO 9001:2015 Quality Management System can be used as the basis for quality control to ensure that the design work conforms to customer requirements and laws and regulations.			
1	Object of work	Obtain task	Obtain the project assignment book including digital modeling expression and optimization of industrial design from relevant departments, including relevant design of piston pneumatic motor and design tasks of automatic production line, etc. Carry out in-depth communication with the project manager in charge of the project, and clarify the key points and difficulties in the industrial design technology research and design optimization of each part. Communicate with customers to understand their specific requirements and expectations on functions, appearance, efficiency, etc. of piston pneumatic motors, automatic production lines and other design results.
		Making plan	Determine the overall objective of digital modeling expression and optimization of the whole industrial design, such as efficient parameterization design in the design of piston pneumatic motor, and rationalityand efficiency of three-dimensional wiring and pipe laying in the design of automatic production line. Carefully analyze various work contents, including the fields to be covered by industrial design technology research, complex structure processing of digital modeling of piston pneumatic motor, intelligent optimization direction of support parts, etc.Develop detailed work steps, such as research on industrial design technology first, and then carry out digital modeling, design expression, efficient parametric design of some parts and other work of piston pneumatic motor in turn. Reasonably allocate the working time to ensure that the work of each stage is completed within the specified project cycle, such as allocating enough time for the intelligent optimization design of piston pneumatic motor bracket parts to carry out algorithm research and test. Prepare a comprehensive work plan to clearly list the objectives, contents, steps and time arrangement of each task. The prepared work plan shall be submitted to the business department for review and confirmation to ensure that the plan meets the overall project requirements and business specifications.
		Virtual model building	Demand analysis and research: analyze the demands of piston pneumatic motor and automatic production line under different working scenarios, and provide basis for subsequent modeling through research on typical design cases and cutting-edge technologies. Model construction: build 3D model of piston pneumatic motor with digital modeling tools, including internal structure, assembly relationship of parts, etc; At the same time, 3D model of automatic production line shall be established, and equipment layout and material transmission path shall be considered. Model optimization: optimize the model of piston pneumatic motor, such as intelligent optimization design of support parts to improve its strength and stability; The layout of wiring and pipe laying shall be optimized for the automatic production line model to reduce interference and energy loss.

Table 1 (*continued*)

Typical work task name			Digital modeling expression and optimization of industrial design
Typical work task description			
1	Object of work	Virtual model building	Material mapping: select proper materials for models of piston pneumatic motor and automatic production line, and carry out mapping processing to make them more realistic in appearance. For example, select wear-resistant and high-temperature material mapping for casing of pneumatic motor.
		Model map rendering	Scenario layout: design presentation scenarios for models of piston pneumatic motors and automatic production lines, such as placing pneumatic motors in realistic work environment simulation scenarios and automatic production lines in workshop scenarios. Light source setting: according to the characteristics of the exhibition scene, set appropriate light sources, such as multi-angle light sources in the display of piston pneumatic motors to highlight the design details; Set the light source simulating natural light in the rendering of automatic production line to enhance the reality. Rendering optimization: optimize the rendering effect, adjust the reflection, refraction and other parameters of the material, so as to achieve the best visual effect of the model after rendering. For example, improve the glossiness of the surface of the piston pneumatic motor model, so as to make the color of the automatic production line model more bright.
		Quality self inspection	Model shape: check whether the shape of the piston pneumatic motor and automatic production line model is accurate, such as whether the shape of the piston, cylinder and other parts of the pneumatic motor meets the design requirements, and whether the shape of the automatic production line equipment is consistent with the actual situation. Material map: confirm whether the material map is fitted, distorted and can accurately reflect the characteristics of the material, such as check whether the metal map of the piston pneumatic motor has a metal sense, and whether the plastic parts of the automatic production line have plastic luster and texture. Model capacity: check the model file capacity to ensure that the file capacity is minimized for storage and transmission without affecting the model quality, such as optimizing the polygon number of piston pneumatic motors and automatic production line models. Model effect: evaluate the performance of the model in terms of overall visual effect and fidelity, for example, observe whether the dynamic effect of the piston.
		Delivery and acceptance	Check the demand sheet: check the completed design results of piston pneumatic motor and automatic production line with the project demand sheet one by one to ensure that all design requirements have been met. Effect acceptance: effect acceptance shall be carried out from the aspects of design functionality, aesthetics and innovation, for example, check whether the performance of the piston pneumatic motor is improved through digital modeling expression and optimization, and whether the three-dimensional wiring and piping of the automatic production line meet the design standards. Signing and delivery: After the customer and relevant departments confirm that the design results meet the requirements, sign and confirm to complete the delivery of design results.pneumatic motor after rendering is smooth, and whether the operation simulation effect of the automatic production line is true.

Table 1 (*continued*)

Typical work task name			Digital modeling expression and optimization of industrial design
Typical work task description			
2	Tools, materials, equipment and data	Obtain task links	Project specification: specify the detailed requirements and expected objectives of all aspects of industrial design digital modeling tasks (such as piston pneumatic motor related design and automatic production line design). Industry research report: including the latest trend, technical development trend and other information in the field of industrial design to provide basic data for industrial design technology research. Customer communication record: record the special requirements and concerns of customers for the design of piston pneumatic motor and automatic production line. Relevant design specification manuals: such as mechanical design specifications, digital modeling standards, etc., providing design basis for subsequent work.
		Preparation of plan links	Project assignment book: reconfirm the specific requirements of each task (including the design expression of piston pneumatic motor, efficient parameterization design of some parts, etc.) to ensure the pertinence of the plan. Design process template: refer to the general industrial design process template and formulate a reasonable workflow based on the characteristics of the project. Time-planning chart: the time node used to clearly allocate tasks, such as the time required for intelligent optimization design of piston pneumatic motor bracket parts. Resource allocation list: list the manpower and material resources required to complete the project, such as software resources, hardware equipment, etc.
		Virtual model building	Digital modeling software: Inventors and Crown CAD: It is suitable for 3D modeling of mechanical structures such as piston pneumatic motors, and can accurately build the geometry of parts. Fusion360: It has advantages in intelligent optimization and can be used for lightweight design and development of some parts. Computer equipment: equipped with high-performance computer to ensure the smoothness of running modeling software, especially when dealing with large automatic production line models. Design parameter manual: including design parameters and material properties of various mechanical parts, providing data support for modeling and optimization of piston pneumatic motor. Model library resources: such as the model library of some general mechanical parts, which can be directly called when building the piston pneumatic motor model, so as to improve the modeling efficiency.
		Model map rendering	Rendering software: Inventor: Capable of providing high-quality ray tracing rendering effects, making models of piston pneumatic motors and automatic production lines more realistic. Fusion360: Realize excellent rendering effect with fast and simple operation, applicable to quick preview of rendering effect of model. Texture library: abundant texture, such as texture of metal, plastic and wood, provides a variety of choices for the texture of piston pneumatic motor and automatic production line model. Lighting simulation equipment: equipment that can simulate different lighting environment can help set lighting conditions more suitable for actual conditions during rendering.

Table 1 (*continued*)

Typical work task name			Digital modeling expression and optimization of industrial design
Typical work task description			
2	Tools, materials, equipment and data	Quality self inspection	Design standard documents: international standards such as ISO 10303:2024 (STEP standard) are used to check whether digital modeling and automatic production line design of piston pneumatic motors comply with specifications. Precision measuring tools: measure the dimensional accuracy of the model to ensure accurate dimensions of all parts of the piston pneumatic motor. Performance test software: conduct performance simulation test on the model of piston pneumatic motor, such as hydromechanical analysis software, and check its operation performance.
		Delivery and acceptance	Project acceptance list: list all acceptance indicators of the project in detail, such as whether the design expression of the piston pneumatic motor is clear, whether the three-dimensional wiring of the automatic production line is reasonable, etc. User feedback questionnaire: collect users' opinions and suggestions on the design results, such as satisfaction with the efficient parameterization design of some parts of the piston pneumatic motor.
3	Work requirements	Obtain task links	Read carefully from the Project Manager and obtain the project requirement list including digital modeling expression and optimization of industrial design to obtain the customer contact information. Collect data related to industrial design technology, piston pneumatic motor and automatic production line through various information retrieval channels, such as professional database and industry website, and obtain effective software planning scheme. Deeply communicate with the business department to understand the overall business process of the project and the position and role of the work therein. At the same time, we have fully communicated with customers to define their specific expectations, application scenarios, performance indexes and other working conditions and objectives for industrial design technology research, piston pneumatic motor design in all aspects and automatic production line design.
		Preparation of plan links	Based on the project demand list and the results of communication with the business department, the overall objective of the digital modeling expression and optimization of industrial design shall be determined, such as the optimization indicators to be achieved in the intelligent optimization design of the piston pneumatic motor support parts, and the efficiency improvement to be achieved in the 3D wiring, piping and simulation analysis of the automatic production line. Make detailed analysis on the work contents, such as determining the fields to be investigated, technical types, domestic and foreign development status, etc. in the industrial design technology research; The design elements and drawing types to be expressed shall be specified in the design expression of the piston pneumatic motor. Scientific and reasonable work steps shall be formulated. First, the research on industrial design technology shall be carried out, then the digital modeling of piston pneumatic motor, intelligent optimization design and design expression of support parts, efficient parameterization design of some parts shall be carried out successively, and finally the three-dimensional wiring, piping and simulation analysis of an automatic production line shall be carried out.

Table 1 (*continued*)

Typical work task name			Digital modeling expression and optimization of industrial design
Typical work task description			
3	Work requirements	Preparation of plan links	Parameterization design of some parts shall be carried out successively, and finally the three-dimensional wiring, piping and simulation analysis of an automatic production line shall be carried out. Reasonably allocate the working time of each stage according to the time node specified in the task book, for example, allocate sufficient time for the digital modeling of piston pneumatic motor to ensure the accuracy of the model, and consider the connection time between each stage. Prepare a comprehensive and detailed work plan, including the objectives, contents, steps, time arrangement and personnel division of each task, and submit it to the business department for review and confirmation.
		Construction link of virtual model	Deeply understand the customer's design requirements for piston pneumatic motor and automatic production line, including performance, appearance, dimensions and other requirements, and get familiar with the characteristics and functions of the selected software development platform. Use appropriate 3D modeling software (such as SolidWorks, UG NX, etc.) for modeling in strict accordance with the project requirements and relevant design standards (such as ISO 16792:2021, etc.). During the modeling process, the geometries of the components of the piston pneumatic motor and automatic production line are precisely created, and the parameters such as their size and position are accurately adjusted. For the piston pneumatic motor, the details of the model shall be further refined after the completion of the basic model, such as adding appropriate materials (such as high-strength alloy steel) and textures to the support parts according to the actual situation, and adjusting the proportion and posture of each part of the model according to the design requirements. For the automatic production line, the equipment shall be reasonably arranged to ensure the accuracy and completeness of the model.
		Model map rendering link	Once the virtual models of piston pneumatic motors and automatic production lines have been constructed, realistic materials, textures and colors have been added to the models. For the piston pneumatic motor, accurate mapping shall be carried out according to the materials of different parts (such as the metal materials of the piston and the plastic materials of the shell) to make the model closer to the actual product in terms of texture. UV segmentation, baking of normal, CV and AO maps to ensure the model displays in different viewing angles and lighting conditions. Maintain a high degree of consistency with the design manuscript in terms of color reduction. Set proper lighting effect, simulate natural light, artificial light, etc. according to working environment of piston pneumatic motor and workshop environment of automatic production line, and enhance representation and reality of model. Upon completion of all model details and texture maps, efficient rendering software (such as V-Ray, Keyshot, etc.) is used for rendering operations to produce high-quality final 3D images.
		Quality self-inspection link	Use the observation method to check the virtual models and texture rendering effects of the piston pneumatic motor and automatic production line from different angles and under different lighting conditions, and check whether the models are deformed, whether the texture is clear and whether the color is accurate.

Table 1 (*continued*)

Typical work task name			Digital modeling expression and optimization of industrial design
Typical work task description			
3	Work requirements	Quality self-inspection link	The digital model of piston pneumatic motor is tested by program test method, such as checking the operation stability of model under different working conditions; Carry out interference inspection and flow test for 3D wiring and piping models of automatic production line to ensure that the models meet the design requirement
		Delivery acceptance link	Invite third-party professional organizations or experts to inspect and accept the results of digital modeling expression and optimization of industrial design according to the requirements of the acceptance form. The third party shall comprehensively evaluate the design quality of the piston pneumatic motor (including the accuracy of the model, the optimization effect, the normalization of the design expression, etc.) and the three-dimensional wiring, piping and simulation analysis results of the automatic production line (such as the rationality of the wiring, the safety of the piping, the reliability of the simulation results, etc.).ign requirements.
4	Method of working	Obtain task links	Brainstorming method: the team members discuss the research direction of industrial design technology, innovation points of piston pneumatic motor design, etc. together, and gather wisdom. Demand analysis method: Deeply analyze customers' demands for digital modeling of industrial design, such as specific requirements for 3D wiring and piping of automatic production line.
		Preparation of plan links	WBS decomposition method: decompose the industrial design digital modeling project into multiple manageable work packages, such as the design of piston pneumatic motor into modeling, optimization, expression and other work packages. PERT network analysis method: analyze the dependency and time estimation among various tasks, and formulate reasonable project schedule
		Virtual model building	Parametric modeling method: in the efficient parametric design of some parts of the piston pneumatic motor, the shape and size changes of the model are controlled by setting parameters. Feature modeling method: model according to the features of mechanical parts (such as shafts, holes, slots, etc.) to improve the modeling efficiency and accuracy.
		Model map rendering	Layered rendering method: divide the models of piston pneumatic motor and automatic production line into different layers for rendering, so as to facilitate adjustment and modification. Environment simulation rendering method: simulate the illumination, shadow and other conditions of the model in the actual working environment for rendering to enhance the sense of reality.
		Quality self-inspection	Cross-check method: different team members check the design of piston pneumatic motor and the design of automatic production line to reduce omission. Historical data comparison method: compare with the design data of similar projects in the past and check whether the quality of the current project meets or exceeds the standard.
		Delivery and acceptance	On-site demonstration method: demonstrate the operation effect of the piston pneumatic motor and the workflow of the automatic production line to the customer on site, and visually display the design results.

Table 1 (*continued*)

Typical work task name			Digital modeling expression and optimization of industrial design
Typical work task description			
			User experience testing method: let the user operate the model or simulation system based on the design results, and collect feedback on user experience.
5	Labor organization mode		Reasonably arrange the number of staff according to the task amount of the industrial design digital modeling project, the complexity of the task (such as the difficulty of intelligent optimization design of piston pneumatic motor bracket parts) and the time requirements. The industrial design engineer is required to obtain the project demand from the project manager. During the implementation of the project, the engineer shall directly communicate with the user when necessary to provide acceptance and Q&A services to ensure the user's understanding and recognition of the design results

Representative work task

Task name	Task description	Learning hours
Cultivate designers with basic hand drawing ability and space thinking ability for enterprises	Objective: Master basic hand-painting skills and design expression methods, and enhance spatial thinking and visual communication ability. Content: learn the basic hand painting skills in industrial design, including perspective, scale, light and shadow and other basic elements. Through a series of exercises, designers will draw sketches of simple geometric shapes, household articles or vehicles, and practice how to accurately express the design intent through hand drawings. Deliverables: Submit a series of hand-drawn sketches (such as coffee cups, chairs, bicycles, etc.) for classroom presentation. Each designer shall complete a separate design review to explain the challenges encountered in the hand-drawing process and how to overcome them. The competent department shall be responsible for review and acceptance.	32 hours
Modeling and design of flywheel parts in a unit	In order to complete the research and development of a new industrial product, the design department of our company assigns a task book to the industrial design technical team, and requires the digital modeling of flywheel parts. The industrial design technical team receives the task book from the design department, obtains the workflow of flywheel part modeling, formulates the flywheel part modeling work plan, collects relevant data and materials according to the requirements of the task book, prepares the software and tools required for modeling, carries out the digital modeling of flywheel parts according to the work plan and workflow, checks and optimizes after the modeling is completed, and delivers the model to the design department for acceptance after ensuring the accuracy of the model. The task shall be completed within 12 hours.	12 hours
Modeling design of cylinder parts per unit	In order to meet the project requirements of a certain unit, the design department of our company issued a task book to the industrial designer, and required to complete the modeling design task of the cylinder parts of the unit. The industrial designer receives the task book from the design department, obtains the modeling workflow of the cylinder parts, formulates the modeling work plan of the cylinder parts, collects relevant data and measurement parameters according to the requirements of the task book, prepares the software and tools required for modeling, carries out the digital modeling of the cylinder parts according to the work plan and the work process, checks and optimizes the modeling after completion, and delivers the model to the design department for acceptance after ensuring that it meets the design requirements. The task shall be completed within 12 hours.	12 hours

Table 1 *(continued)*

Typical work task name	Digital modeling expression and optimization of industrial design	
Representative work task		
Task name	Task description	Learning hours
Modeling design of a unit support part	In order to meet specific production requirements, an organization entrusts our company to carry out modeling design of support parts. The industrial designer obtains the task book from the design department, prepares the tools and software required for modeling according to the task book, and formulates the modeling work plan of the support parts. Data acquisition and analysis according to the work plan, and digital modeling of support parts with professional knowledge and skills. In the process of modeling, possible technical difficulties shall be handled, the modeling work record form shall be filled in, submitted to the entrusting unit for signature and confirmation, and submitted to the design department. This task is delivered within the specified time.	12 hours
Digital design and assembly of certain unit piston pneumatic motor	An organization plans to carry out digital design and assembly of piston pneumatic motors to meet production or work requirements. The industrial design team obtains the task book from the design department, prepares relevant design and assembly tools and software according to the task book, and formulates the digital design and assembly work plan of piston pneumatic motor. Detailed scheme design, data calculation and analysis shall be carried out according to the work plan, and digital modeling, design optimization and assembly simulation of piston pneumatic motor shall be carried out with professional knowledge and advanced technology. In the process of design and assembly, possible technical difficulties shall be handled, the work record form shall be filled in, submitted to the entrusting unit for signature and confirmation, and submitted to the design department. This task requires high quality delivery within the scheduled time frame.	24 hours
Market research on derivative design of an enterprise	In order to expand the business field, an enterprise decides to carry out a derivative product design work. The business department assigns a task book to the team responsible for industrial design, and requires market research on the derivative product to provide strong support for subsequent design and development. The industrial design team receives the task book from the business department to define the specific requirements and objectives of the investigation. This research requires an in-depth understanding of the current situation of similar derivatives in the market, including but not limited to product characteristics, user needs, competitive situation, etc. The design team obtains the workflow and methods of market research and formulates a detailed research plan. Determine the scope and focus of the investigation according to the requirements of the assignment book, and prepare the required investigation tools and data. Based on the research plan and workflow, the design team conducts research through various channels and methods, such as online questionnaires, offline interviews, market observation, etc. Collect and analyze a large amount of primary data and information. Complete the research work within the specified time, form a comprehensive, accurate and targeted market research report, and deliver it to the business department for acceptance. It provides scientific and reliable basis for the derivative product design of the enterprise and helps the enterprise to take a dominant position in the market competition.	24 hours

Table 1 (*continued*)

Typical work task name	Digital modeling expression and optimization of industrial design	
Representative work task		
Task name	Task description	Learning hours
Derivative design of a unit piston pneumatic motor bracket part	In order to improve the performance and stability of piston pneumatic motor during production, a unit decides to carry out derivative design for its support parts. The team responsible for the design task obtains the task book from the business department to define the specific requirements and objectives of the design. The working environment and load of the pneumatic motor as well as the shortcomings of the existing support parts shall be comprehensively considered in this design. The design team shall prepare relevant design tools and data according to the requirements of the task book, and prepare detailed derivative design work plan for piston pneumatic motor support parts. Based on the work plan, the design team uses advanced design concepts and methods to carry out innovative design on the structure, materials, process and other aspects of the support parts. During the design process, mechanical property, manufacturing feasibility and cost shall be fully considered to continuously optimize the design scheme. Upon completion of preliminary design, simulation analysis and test shall be carried out to verify the rationality and reliability of the design. Timely adjust and improve the problems and deficiencies. Fill in the detailed work record form, record the key data and decisions in the design process, and submit to the business department for review after the user signs for confirmation. Provide better performance and more stable piston pneumatic motor bracket parts for unit production.	48 hours
Two-dimensional drawing of sheet metal parts in an enterprise	In order to undertake an order of a certain number of sheet metal parts, the business department of our company assigns a task book to the industrial designer of the company, and requires the designer to complete the two-dimensional engineering drawing drawing of this batch of sheet metal parts. The business department shall specify the quantity and specific specification requirements of the sheet metal parts to be drawn for this task. The designer shall obtain the task book from the business department, obtain the workflow of two-dimensional engineering drawing, and formulate the two-dimensional engineering drawing work plan. Prepare tools and materials required for drawing according to the requirements of the task book, and carefully draw the 2D engineering drawing according to the work plan and workflow. Self-inspection and correction shall be carried out after the drawing is completed to ensure that the drawings are accurate and marked clearly and normatively, and then the drawings shall be delivered to the business department for acceptance. The whole task shall be completed within the specified time to ensure the smooth progress of subsequent production work.	24 hours
Engineering drawing of piston pneumatic motor assembly in an enterprise	An enterprise receives an order of a batch of piston pneumatic motors. In order to ensure the smooth progress of subsequent production and assembly work, it is necessary to draw the assembly engineering drawing of piston pneumatic motors. The industrial designer obtains the task book from the business department, which specifies the technical parameters and assembly requirements of the piston pneumatic motor. The designer shall prepare tools required for drawing according to the requirements of the task book, and prepare a detailed plan for drawing the assembly engineering drawing of piston pneumatic motor. Draw engineering drawings gradually in strict accordance with relevant drawing standards and specifications according to the work plan. Each detail shall be carefully prepared during preparation to ensure the accuracy and completeness of the engineering drawings. Upon completion of drawing, self-inspection and correction shall be carried out for the engineering drawing, and the work record form shall be filled in and submitted to the business department for review and confirmation.	48 hours

Table 1 (*continued*)

Typical work task name	Digital modeling expression and optimization of industrial design	
Representative work task		
Task name	Task description	Learning hours
Rendering of piston pneumatic motor of certain unit	In order to promote piston pneumatic motor products, an organization needs to make a batch of exquisite renderings for publicity and display. The industrial designer shall obtain the task book from the business department to define the production requirements of the piston pneumatic motor rendering, including the presentation angle, color matching, detail presentation, etc. Obtain the workflow of rendering and prepare a detailed plan for rendering of piston pneumatic motor. Prepare the required software and tools and collect relevant reference materials according to the requirements of the task book. Elaboration of rendering according to the work plan and workflow, and attention to light and shadow effect, material performance and overall visual impact. Repeated commissioning and optimization shall be carried out after the preliminary production is completed to ensure that the effect picture reaches the expected effect. After the operation is normal, it shall be delivered to the business department for acceptance.	48 hours
Animation production of working principle of piston pneumatic motor in an enterprise	In order to show the working principle of piston pneumatic motor to customers more clearly and intuitively, an enterprise needs to make relevant animation. The animation designer obtains the task book from the business department to define the production requirements for the animation of the working principle of the piston pneumatic motor, including the animation duration, picture style, key display contents, etc. Prepare relevant production software and tools according to the requirements of the task book, and prepare a detailed animation production work plan for the working principle of the piston pneumatic motor. Based on the work plan, the working principle of the piston pneumatic motor shall be deeply studied, animation script and splitter shall be designed, the preliminary animation shall be made, and the technical problems occurred in the production process shall be handled. Upon completion of the preliminary fabrication, repeated checks and optimisations were carried out to ensure that the animation accurately and vividly represented the working principle of the piston pneumatic motor. Fill in the work record form and submit it to the business department for review and confirmation.	48 hours
Animation production for disassembly and assembly of certain unit piston pneumatic motor	In order to provide intuitive learning materials for technical personnel and maintenance personnel, a unit needs to make piston pneumatic motor disassembly animation. The animation designer shall obtain the task book from the business department to define the production requirements for the disassembly and assembly animation of the piston pneumatic motor, such as the display sequence of the disassembly and assembly steps, close-up processing of key parts, etc. Obtain the workflow of animation production, and prepare the work plan for the disassembly and assembly animation production of piston pneumatic motor. Prepare the required animation production software and tools and collect relevant reference materials according to the requirements of the task book. Carefully design animation scripts and separators according to the work plan and workflow, gradually produce animation and solve technical difficulties encountered in the production process. Carefully debug and optimize animation after preliminary production to ensure clear and accurate disassembly steps and smooth and natural animation effect. Deliver to the business department for acceptance after the operation is correct.	48 hours

Table 1 *(continued)*

Typical work task name	Digital modeling expression and optimization of industrial design	
Representative work task		
Task name	Task description	Learning hours
Some unit uses IPArt tool to customize screw parts	To meet the production requirements of a specific product, an organization needs to customize screw parts using the iPart tool. Designers obtain task books from the business to define the requirements for custom screw parts using iPart tools, such as size, material, accuracy, etc. Get a process for custom work and create a work plan for custom screw parts using the iPart tool. Prepare relevant software and tools and collect the required reference data according to the requirements of the task book. Use iPart tools to custom design parts and address design issues based on work plans and workflows. Upon completion of the preliminary design, careful inspection and optimization shall be carried out to ensure that the parts meet the design requirements. Fill in the work record form and submit it to the business department for review and confirmation.	48 hours
An organization customizes shaft parts with the ifeature tool	To meet the manufacturing requirements of a specific product, it is necessary to customize shaft parts using the iFeature tool. The designer receives the task book from the business department, and defines the detailed requirements for customized shaft parts with iFeature tools, such as shaft length, diameter, tolerance, surface roughness, etc. Obtain a process for custom work and develop a work plan for custom shaft parts using the iFeature tool. Count the required software and tools and prepare relevant reference materials according to the requirements of the task book. Based on the work plan and workflow, use the iFeature tool to carry out the customized design of shaft parts and handle the technical problems in the design process. Comprehensive inspection and optimization shall be carried out after the preliminary design is completed to ensure that the shaft parts meet the requirements of the task book. Conduct commissioning and deliver to the business department for acceptance after normal operation.	48 hours
An enterprise customized plate cover parts with ilogic tools	To meet the production needs of a specific product, an enterprise decides to use the iLogic tool to customize the disk cover parts. The designer obtains the task book from the business department, and clearly uses the iLogic tool to customize the specific requirements of the plate cover parts, such as the shape, size, thickness, hole distribution, etc. of the plate cover. Obtain the process of customized work and prepare a work plan for customized plate cover parts with iLogic tools. Prepare relevant software and tools and collect necessary reference materials according to the requirements of the task book. Based on the work plan and workflow, use the iLogic tool to custom design the plate cover parts, and handle various problems in the design process. Upon completion of preliminary design, rigorous inspection and optimization shall be carried out to ensure that the plate cover parts meet the design requirements. Fill in the work record form and submit it to the business department for review and confirmation.	48 hours
An enterprise creates a mold with a derivative	In order to meet the production requirements of a product, an enterprise needs to use derivatives to create a mold. The mold designer shall obtain the task book from the business department, and define the requirements for creating the mold by using derivatives, such as the type, size and specification of the mold, precision standard, etc. Obtain workflow for creating tooling and prepare work plan for creating tooling with derivatives. Count the required software and tools and prepare relevant reference materials according to the requirements of the task book. Use derivatives to create tooling according to work plan and workflow, and handle technical problems during creation. Careful inspection and optimization shall be carried out after the preliminary creation to ensure that the mould meets the requirements of the task book. Conduct commissioning and deliver to the business department for acceptance after normal operation.	48 hours

Table 1 (*continued*)

<table>
<tr><td colspan="2">Typical work task name</td><td colspan="2">Digital modeling expression and optimization of industrial design</td></tr>
<tr><td colspan="4">Representative work task</td></tr>
<tr><td>Task name</td><td colspan="2">Task description</td><td>Learning hours</td></tr>
<tr><td>Complete 3D wiring optimal design of complex equipment for enterprises</td><td colspan="2">Objective: Designers need to create accurate 3D wiring models for a complex industrial facility, such as an automated production line or large machinery. The focus is on optimizing cable routing to avoid cross, overlap and interference and to ensure cable maintainability.
Content: Construct 3D wiring models using advanced CAD tools such as inventor, Crown CAD or Fusion360.
The optimal wiring path shall be designed according to electrical specifications and actual installation requirements.
Conduct simulation analysis to verify the feasibility and reliability of wiring design.
Deliverables: integrity and optimization report of wiring model, including wiring path, cable length calculation and installation process suggestions. The competent department is responsible for review and acceptance.</td><td>40 hours</td></tr>
<tr><td>Complete 3D piping and pressure analysis of fluid pipeline system for enterprises</td><td colspan="2">Objective: To design a three-dimensional piping model in a high-pressure fluid system, such as a chemical plant or cooling system, and to perform a pressure analysis of the piping to ensure its safety and stability under different operating conditions.
Content: Use professional CAD tools to design 3D pipe layout model, and consider space constraints, pipe material and connector selection.
Conduct pressure simulation analysis to evaluate the stress and deformation of the pipeline under high pressure and temperature change.
Propose pipeline design optimization suggestions to ensure the reliability and long service life of the system.
Deliverables: Complete piping model and pressure analysis report, including stress distribution diagram and optimization scheme, and the competent department is responsible for review and acceptance.</td><td>32 hours</td></tr>
<tr><td>Dynamic motion simulation of mechanical system for enterprises</td><td colspan="2">Objective: To design a 3D model of a multi-axis mechanical system such as a robotic arm or complex gearing, and perform dynamic motion simulation to verify its kinematic and dynamic characteristics.
Content: Use CAD software (such as inventor, Crown CAD or Fusion36 to create a 3D model to precisely set the motion constraints of each component.
Conduct motion simulation to analyze the motion trajectory, speed, acceleration and reaction force of the system under different loads and speeds.
Optimize the design parameters of the system to ensure its motion stability and accuracy.
Deliverables: motion simulation video and analysis report, including motion trajectory, key parameters and optimization suggestions. The competent department is responsible for review and acceptance.</td><td>40 hours</td></tr>
<tr><td>Complete structural stress analysis and optimization of high stress parts for enterprises</td><td colspan="2">Objective: to analyze the structural stress of a mechanical component (such as gear, bearing housing or supporting structure) affected by high stress and propose an optimal design scheme.
Content: establish detailed three-dimensional model of high stress components, and consider material characteristics and working environment.
The stress, strain and fatigue life of the component are analyzed by the finite element analysis software.
Propose recommendations for material selection or geometry optimization to reduce stress concentrations and extend component life.
Deliverables: stress analysis report and optimization design suggestions, including stress distribution diagram, stress concentration area and comparison before and after optimization. The competent department is responsible for review and acceptance.</td><td>40 hours</td></tr>
</table>

Table 1 (*continued*)

<table>
<tr><td>Typical work task name</td><td colspan="2">Digital modeling expression and optimization of industrial design</td></tr>
<tr><td colspan="3">Representative work task</td></tr>
<tr><td>Task name</td><td>Task description</td><td>Learning hours</td></tr>
<tr><td>Complete 3D piping and thermal stress simulation of complex fluid equipment for enterprises</td><td>Objective: To design a three-dimensional tube layout model of fluid equipment (such as boiler or heat exchanger) operating in high temperature environment and conduct thermal stress simulation to ensure thermal stability of equipment.
Contents: establish the three-dimensional pipe layout model of equipment, select the appropriate high-temperature resistant materials, and design the effective thermal expansion compensation scheme.
The thermal stress simulation tool is used to analyze the thermal stress distribution of the equipment under different temperature gradients and its influence on the structure.
Through the simulation results, the design is optimized to reduce the thermal stress and structural deformation.
Deliverables: thermal stress analysis report, including thermal stress distribution diagram, deformation analysis and optimization suggestions. The competent department is responsible for review and acceptance.</td><td>32 hours</td></tr>
<tr><td>Complete the integrated simulation and stress analysis of mechanical system for enterprises</td><td>Objective: Design a 3D model of small and medium-sized mechanical system (such as mine equipment or ocean engineering equipment), conduct integrated simulation and stress analysis, and evaluate the performance and reliability of the system in complex environment.
Content: establish detailed 3D model of the system, integrate wiring, piping, moving parts and structural parts.
The integrated simulation software is used for multi-physical field simulation of the system to analyze the stress and deformation under complex environment (such as high temperature, high pressure or vibration). Propose system design optimization scheme to enhance durability and safety.
Deliverables: integrated simulation and stress analysis report, including comprehensive stress distribution diagram, optimization scheme of key components and environmental adaptability analysis, and the competent department is responsible for review and acceptance.</td><td>40 hours</td></tr>
</table>

Reverse design and improvement of typical work tasks are shown in detail in table 2.

Table 2 Typical task description for reverse design and improvement

<table>
<tr><td>Typical work task name</td><td>Reverse design and improvement</td></tr>
<tr><td colspan="2">Typical work task description</td></tr>
<tr><td colspan="2">In the field of industrial design, the application of reverse design technology is becoming an important way to realize product innovation and optimization. With the changing market demand and the development of personalized trend, the demand for accurate restoration and improvement of complex shape products is increasing. To meet these needs, designers need to use reverse design techniques to accurately reverse design and improve plaster avatar parts, spectacle frames, etc.
The purpose of this task is to provide efficient and accurate reverse engineering solutions for products with complex shapes. Through the reverse engineering of these products, designers can obtain accurate three-dimensional data, and on this basis, carry out innovative design and optimization improvement to improve the quality of products and market competitiveness.
Reverse design of plaster avatar parts
Use high-precision measuring equipment and scanning technology to obtain detailed outline data of gypsum avatar parts.
Analyze and process the acquired data according to relevant art standards and ergonomic requirements to ensure the accuracy and aesthetics of reverse design.
Reverse design and improvement of spectacle frames.</td></tr>
</table>

Table 2 (*continued*)

<table>
<tr><td colspan="2">Typical work task name</td><td colspan="2">Reverse design and improvement</td></tr>
<tr><td colspan="4">Typical work task description</td></tr>
<tr><td colspan="4">Original shape and structure data of spectacle frame are obtained by advanced reverse engineering.
The dimensional and geometric tolerances of the spectacle frames are controlled to ensure comfort and stability of wear in accordance with ISO 2768:1989 General tolerances for mechanical engineering.
Combined with the market trend and user needs, the spectacle frame is innovatively improved and designed to improve the functionality and sense of fashion of the product.
Through comprehensive application of reverse design technology and relevant standards, designers can complete high-quality reverse design tasks, provide strong support for product R&D and production, and meet market demands for personalized and high-quality products.</td></tr>
<tr><td rowspan="5">1</td><td rowspan="5">Object of work</td><td>Obtain task</td><td>Requisition of reverse design brief
Obtain reverse design workflow
Communicate requirements and details with relevant departments</td></tr>
<tr><td>Making plan</td><td>Define reverse design Objectives
Analysis of design contents, key points and difficulties
Planning detailed design steps
Reasonably allocate the working time of each stage
Prepare reverse design work plan
Submitted to competent department for review and confirmation</td></tr>
<tr><td>Implement reverse design</td><td>Collect raw data
Selection of appropriate reverse engineering software and tools
Data processing and model building
Model optimization and detail improvement</td></tr>
<tr><td>Quality self inspection</td><td>Check model accuracy and accuracy
Conduct model function simulation test</td></tr>
<tr><td>Delivery and acceptance</td><td>Check whether the design requirements are consistent with the results
Carry out function and effect acceptance
Both parties sign and complete the delivery</td></tr>
<tr><td rowspan="5">2</td><td rowspan="5">Tools, materials, equipment and data</td><td>Obtain task links</td><td>Reverse design task book (including technical specification sheet), reverse design workflow, relevant product instructions and installation guidelines</td></tr>
<tr><td>Planning links</td><td>Reverse design task book, reverse design workflow, reverse design process record form</td></tr>
<tr><td>Reverse design links</td><td>Related product objects, product instructions, installation guidelines, work plans, reverse design workflow, reverse design process record forms, 3D scanners, modeling software, measuring tools (such as caliper and micrometer), marker pens, protective gloves, protective glasses, cleaning cloth, model repair materials, model printing materials</td></tr>
<tr><td>Quality self-inspection link</td><td>Reverse design task book, inspection software</td></tr>
<tr><td>Delivery and acceptance link</td><td>Reverse design assignment and acceptance sheet</td></tr>
</table>

Table 2 (*continued*)

Typical work task name		Reverse design and improvement	
Typical work task description			
3	Work requirements	Obtain the task link	Obtain the reverse design task book from the R&D department, and understand the function, structure and technical characteristics of the target product through market research and data collection. Communicate with R&D Department to define the objectives and expected results of reverse design.
		Preparation of planning links	According to the reverse design task book and market research results, define the design objectives, analyze the product structure and technical requirements, and prepare detailed reverse design steps and time plans. Complete the reverse design work plan and submit it to the R&D Department for review and confirmation.
		Reverse design implementation link	Disassemble, measure, analyze and model the product according to the work plan and product technical data. In this process, ensure that appropriate measurement tools and modeling software are used, relevant intellectual property laws and regulations are observed, and the legality and accuracy of the design process are ensured.
		Quality self-inspection link	Verify whether the reverse-designed product meets the performance standard and functional requirements of the original product through comparative analysis and functional test. Ensure the accuracy and reliability of reverse design.
		Delivery acceptance link	Sort out the reverse design documents and relevant data, and prepare the delivery materials according to the company's standards. Provide the R&D Department with acceptance Q&A service when necessary to ensure that the reverse design results meet the expected objectives.
		Professional quality requirements	In the process of reverse design, strictly abide by the industry ethics and company regulations, and it is prohibited to violate the intellectual property rights of others. Keep professional and honest when communicating with R&D Department to ensure the smooth progress of reverse design
4	Method of working	Obtain task link	Information collection and analysis
		Planning link	-
		Implementation of reverse design	Scanning method, measurement method, modeling method and comparison method
		Quality self-inspection link	Observation method, software detection method
		Delivery acceptance link	-
5	Labor organization mode		This task is mainly completed by individuals. Designers are required to obtain the task book from the competent department, and provide acceptance and Q&A services to customers if necessary.

Table 2 (*continued*)

Typical work task name	Reverse design and improvement	
Task name	Task description	Learning time
Reverse design of plaster statue parts in a unit	Some unit entrusted our company for reverse design of gypsum avatar parts due to specific needs. Our industrial design team receives the task book from the business department, obtains the reverse design workflow of gypsum avatar parts, and formulates the reverse design work plan of gypsum avatar parts. Prepare relevant measurement and modeling tools according to the requirements of the task book, collect and analyze the data of gypsum avatar parts, conduct reverse modeling and design optimization according to the work plan and workflow, inspect and debug after the design is completed, and deliver the design results to the business department for acceptance after the design meets the requirements. This task shall be completed within the specified time.	48 hours
Reverse design of spectacle frames in a spectacles enterprise	For this eyewear business, a critical reverse design project is launched to deeply analyze and optimize existing eyewear products. The core of the project is to accurately measure and analyze the structure, material, process and ergonomic design of the popular and highly evaluated spectacle frames in the market by means of reverse engineering. In this process, advanced technologies such as 3D scanning, material analysis and user experience research shall be comprehensively used to ensure the accuracy and foresight of reverse design. The goal is to design a new generation of spectacle frames that not only conform to the market trend, but also surpass the competitive products based on the detailed reverse analysis results. The new design needs to take into account aesthetics, wear comfort and manufacturing cost control to enhance the brand image and enhance market competitiveness. The project period is expected to be 48 hours, during which regular progress reports are required to ensure that the project is smoothly advanced to the mass production stage.	48 hours

The typical work tasks of digital manufacturing of parts are shown in detail in table 3.

Table 3 Typical task description for digital manufacturing of parts

Typical work task name	Digital manufacturing of parts
Typical work task description	
In today's industrial design field, the application of digital manufacturing technology is becoming the key force to promote the innovation and development of the manufacturing industry. With the continuous improvement of market requirements for product quality, performance and production efficiency, the accuracy and efficiency of digital manufacturing technology are becoming increasingly prominent. In order to meet diversified production requirements, designers must master and use various digital manufacturing technologies to accurately manufacture molding die parts, shelf supports, lightweight supports, etc. The purpose of this task is to provide a comprehensive and efficient digital manufacturing technology solution for the manufacturing of industrial products. Through the implementation of tasks such as the application of manufacturing technology of reduced materials of forming die parts, the application of manufacturing technology of increased materials of shelf support, and the composite processing practice of increased and reduced materials of lightweight support, the designer can realize the high-quality, high-precision and high-performance manufacturing of products in the actual production. a) Application of material reduction manufacturing technology for forming mould parts. 1) Determine the dimension, shape and precision requirements of forming mould parts according to product requirements and design requirements; 2) Geometric tolerances and fit relationships for die parts are designed in accordance with ISO 2768:1989 General Tolerances for Mechanical Engineering and ISO 286:2010 Dimensional Tolerances and Fit Standards;	

Table 3 (*continued*)

<table>
<tr><td colspan="2">Typical work task name</td><td colspan="2">Digital manufacturing of parts</td></tr>
<tr><td colspan="4">Typical work task description</td></tr>
<tr><td colspan="4">3) Select appropriate material reduction manufacturing processes, such as CNC milling and grinding, and optimize cutting parameters to improve processing efficiency and surface quality.
b) Application of shelf support additive manufacturing technology.
1) Analyze the service environment and bearing requirements of the shelf support, and determine its material and structural design scheme;
2) Use additive manufacturing techniques, such as 3D printing, to accurately fabricate shelf supports according to the Design;
3) Comply with relevant standards to ensure material performance and molding quality during additive manufacturing.
c) Composite processing practice of increase and decrease materials of lightweight support.
1) Optimize the structure of the lightweight support to minimize the weight on the premise of meeting the mechanical Properties;
2) Comprehensively use additive manufacturing and reducing manufacturing technologies, initially form through additive manufacturing, and then conduct fine machining through reducing manufacturing.
3) Refer to ISO 1101:2017 Geometric Product Specification (GPS) for mechanical engineering to control machining accuracy and shape requirements.
Through the implementation of the above typical tasks and comprehensive application of relevant standards and technologies, designers can complete high-quality digital manufacturing tasks, provide strong guarantee for the manufacturing of industrial products, and meet the market demand for high-quality and high-performance products.</td></tr>
<tr><td rowspan="7">1</td><td rowspan="7">Object of work</td><td>Preparation in advance</td><td>Collect relevant data
Get familiar with equipment performance
Communicate with technical team</td></tr>
<tr><td>Design scheme</td><td>Determine the design idea
Prepare preliminary drawings
Evaluate feasibility
Optimized design scheme
Develop detailed design documentation
Submit to the superior for review</td></tr>
<tr><td>Material preparation</td><td>Selection of raw materials
Inspection of material quality
Classified Storage Materials</td></tr>
<tr><td>Manufacturing of additive</td><td>Equipment commissioning
Import model data
Monitoring the manufacturing process
Deal with manufacturing defects</td></tr>
<tr><td>Material reduction processing</td><td>Set processing parameters
Operating processing equipment
Detection of machining accuracy</td></tr>
<tr><td>Product inspection</td><td>Visual inspection
Dimension measurement
Performance test</td></tr>
<tr><td>Packaging and delivery</td><td>Selection of appropriate packaging materials
Carry out product packaging
Delivery to customer for acceptance
Collect feedback opinions</td></tr>
</table>

Table 3 (*continued*)

Typical work task name			Digital manufacturing of parts
Typical work task description			
2	Tools, materials, equipment and data	Obtain task links	Task book of additive manufacturing (including technical parameter list), workflow of additive manufacturing, workflow of reduced material manufacturing, relevant equipment instructions and installation operation guide
		Planning links	Task book of additive manufacturing, workflow of additive manufacturing, workflow of reduced material manufacturing and record sheet of manufacturing process of additive and reduced material
		Implementation of manufacturing	Links of material addition and material reduction: related equipment, equipment instructions, installation instructions, work plan, material addition manufacturing workflow, material reduction manufacturing workflow, material addition and material reduction manufacturing process record form, 3D printer, laser cutting machine, milling machine, drilling machine, file, sand paper, measuring tools (such as vernier caliper and height ruler), fixture, fixing device, protective mask, protective earplug, lubricating oil, cutting fluid, metal materials, plastic materials
		Quality self-inspection link	Additive manufacturing specification, quality inspection software
		Delivery and acceptance link	Additive manufacturing task book and acceptance report
3	Work requirements	Obtain task link	Obtain task book from competent department, obtain workflow of digital manufacturing technology application (increase/decrease of materials) through information collection and analysis, fully communicate with competent department and define work direction.
		Formulation of planning links	Specific objectives of the work shall be established according to the task book and communication results. Refer to the workflow of digital manufacturing technology application (increase and decrease of materials), analyze the work content, plan the work steps, allocate the work time according to the task book, prepare the detailed work plan, and submit it to the competent department for review and approval.
		Implement additive and subtractive manufacturing processes	Follow the work plan, relevant equipment manuals and work processes to carry out the work. In this process, optimize the layout of the work site, operate equipment tools correctly, take protective measures, strictly control the quality and specifications of materials, ensure that the machining accuracy meets the requirements, and use and handle materials in accordance with relevant regulations
		Quality self-inspection link	Use observation method and software inspection method to check whether the manufacturing results meet the standards of the task book.
		Delivery and acceptance	The work site shall be rectified according to "7S" standard, and the acceptance and Q&A service shall be provided for customers if necessary.
		Professional quality requirements	It is strictly prohibited to use unlicensed technology or materials in the manufacturing process, and highlight the precautions for the use and maintenance of the product to the customer.

Table 3 (*continued*)

Typical work task name			Digital manufacturing of parts	
Typical work task description				
4	Method of working	Obtain task link	Information summary and arrangement	
		Planning link	-	
		Implementation of manufacturing links of adding materials and reducing materials	Printing method of adding materials, cutting method of reducing materials, precision control method and material selection method	
		Quality self-inspection link	Visual inspection method, software analysis method	
		Delivery acceptance link	-	
5	Labor organization mode		This task is mainly completed by individuals, and the manufacturing personnel are required to obtain the task book from the competent department, and provide the customer with acceptance and Q&A services if necessary.	
Representative work task				
Task name	Task description			Time
Application of reduced Material manufacturing technology for forming die parts in an enterprise	In order to improve the manufacturing efficiency and precision of our forming die parts, the material reduction manufacturing technology is specially introduced. The project aims to carry out high-precision and high-efficiency cutting of die parts through advanced numerical control processing methods, so as to realize the integrated molding of complex structural parts. The team members are required to be familiar with the material reduction manufacturing process, be able to skillfully operate the relevant numerical control equipment, and have a deep understanding of the mold design. The project objective is to optimize the mould manufacturing cycle, reduce the production cost, improve the product quality and meet the market demand.			48 hours
Application of additive manufacturing technology for shelter support in a unit	The company plans to use additive manufacturing technology (also known as 3D printing technology) to design and manufacture a batch of efficient and customized shelf supports for specific working areas. The project aims to optimize space utilization, enhance structural stability and reduce material waste through advanced digital design and manufacturing technologies. Tasks include demand analysis, 3D modeling, material selection and optimization, printing process development, finished product assembly and performance test, etc. to ensure that the final product meets the use requirements, and promote the technical progress and application practice of the unit in the intelligent manufacturing field.			48 hours
Practice of composite processing of increase and	In order to enhance the competitiveness of the product, our company has decided to carry out the composite processing practice of increase and decrease materials of lightweight support. The project aims to achieve optimal design and precision manufacturing of stent structures by integrating additive manufacturing (e.g. 3D printing) with reduced material processing (e.g. CNC milling). The specific tasks include: designing the composite processing scheme of the lightweight support to ensure that the material use efficiency is maximized and the performance meets the standard; Set up a composite processing platform to realize seamless docking of two technologies; Optimize process flow, improve processing efficiency and yield; Evaluate the processing effect, collect feedback and continuously improve. This practice will bring technological breakthrough and market opportunities for the company.			48 hours

4.2 Curriculum orientation

The curriculum standard of industrial design technology contest aims to cultivate the professional skills and innovation ability of BRICS trainees in the field of industrial design. The curriculum shall cover the following competency areas:

a) Design thinking. Develop problem solving and creative thinking so that they can use design thinking methods to identify problems, explore solutions, and prototype.
b) Application of design tools. Ensure that trainees are familiar with software tools related to industrial design, such as CAD (computer assisted design), 3D modeling, rendering, engineering drawing, reverse technology, increase and decrease of material technology, etc.
c) Knowledge of materials and workmanship. Teach trainees the properties of various industrial materials, machining processes and how to select the appropriate materials and processes to achieve the design objectives.
d) User experience design. Emphasize the importance of the user experience and teach participants how to optimize the product design through user research, user interface design, and user testing.
e) Sustainable design. Develop trainees' ability to consider environmental impacts and sustainability in the design process, including ecological design principles and the concept of circular economy.
f) Project management. Provide basic knowledge of project management so that trainees can effectively plan, execute and monitor design projects.
g) Teamwork and communication. Strengthen team spirit and communication skills to ensure that trainees can work effectively in interdisciplinary teams and communicate effectively with stakeholders.
h) Entrepreneurship and business awareness. Introduce basic business knowledge and entrepreneurial skills to help trainees understand market demands, business models and product promotion strategies.
i) International standards and regulations. Familiarize trainees with international industrial design standards and relevant regulations to ensure that the design works comply with the compliance requirements of the international market.
j) Passport of skills. The curriculum shall be combined with a skill-safe photograph to ensure that the curriculum has been completed with a certification that demonstrates their level of professional skills in the field of industrial design.
k) Through these curriculums, trainees will be able to acquire comprehensive knowledge and skills of industrial design, prepare for BRICS community standard industrial design technology related events, and demonstrate their professional competence under the framework of skill passport.

5 Curriculum objectives

5.1 Knowledge objectives

The contents of knowledge objectives are as follows.

a) Understand the concept, development history and characteristics of industrial design technology;
b) Familiar with relevant terms in industrial design technology;
c) Master the concept, operation process and application field of reverse design;
d) Understand the role and significance of motion simulation and stress analysis in digital design, and the relationship between them;
e) Familiar with the basic concepts of additive manufacturing (3D printing), reduced manufacturing and computer assisted manufacturing;
f) Master the general process, pre-processing and basic operation methods of 3D printing;
g) Understand the NC machining programming process of Fusion 360 software manufacturing module;
h) Get familiar with the basic operation methods of numerical control equipment;
i) Know the general process of composite processing of increase/decrease materials;
j) Identify typical industry applications of additive manufacturing (3D printing) technology.

5.2 Skill objectives

The contents of knowledge objectives are as follows.

a) Capable of creating 3D models of moderately complex industrial products using software;
b) The processing parameters can be reasonably set according to the process requirements of industrial product parts;
c) Comprehensive process analysis for automatic programming of industrial product parts of moderate complexity;
d) Be able to use modeling software to generate data processing programs for moderately complex industrial product parts;
e) Skillfully use relevant software to increase and reduce materials;
f) Master the skills of 3D scanner for data scanning and post-processing with corresponding software;
g) Learn to use a variety of tools to obtain and effectively process information about industrial design techniques;
h) Be able to collect industrial design information by observation, experiment, data reference and other methods, and handle it by means of comparison, classification, and summarization;
i) Be able to use the concepts and methods of derivative design for personalized product design;
j) Be able to produce engineering drawings, renderings, working principle animation and disassembly animation of industrial products;
k) Proficient in efficient design with fast design tools for parts and components;
l) Master 3D wiring and 3D piping skills;
m) Using motion simulation and stress analysis to evaluate and optimize product performance;
n) Individual innovative design of products based on reverse design method;
o) It can apply the composite processing technology of increase and decrease materials to the actual case;
p) Be able to plan, reflect, evaluate and regulate the process of industrial design learning and practice, and continuously improve the ability of independent learning and innovation.

5.3 Standard of accomplishment

The standards of accomplishment are as follows.

a) Have a certain questioning ability; analyze and solve problems;
b) Have a scientific attitude and scientific spirit of adhering to truth, being brave in innovation and seeking truth from facts;
c) Teamwork with others;
d) Develop a careful, practical and realistic scientific attitude and work style of active exploration;
e) Form a good habit of combining theory with practice, learning independently and exploring innovation.

6 Curriculum content

6.1 Theory of knowledge

See table 4 for theoretical knowledge comparison.

Table 4 Comparison table of theoretical knowledge

No.	Theoretical knowledge points	Theoretical knowledge points	The relevant knowledge described in the corresponding skill criteria
1	Concept and development of industrial design technology characteristics of industrial design technology and related terms	Current health and safety regulations relating to the industrial design technology industry Use and maintain personal protective equipment and clothing Recommendations and information published by product and equipment suppliers or manufacturers Procedures for maintenance and use of specialized equipment Terms and Symbols Related to Industrial Design Technology Terms and symbols related to mechanical design and manufacturing process	Basic knowledge of national standard drawing Concept of projection method Projection method knowledge commonly used in engineering drawing Concept of feature analysis method Principles and methods of dimension annotation Concept of various technical requirements

Table 4 (*continued*)

No.	Theoretical knowledge points	Theoretical knowledge points	The relevant knowledge described in the corresponding skill criteria
2	Reverse design concept reverse design operating process reverse design applications	Mechanical drawing and related knowledge of 3D digital scanning equipment: master the knowledge of mechanical drawing, be familiar with the operation principle 3D digital scanning equipment, understand the advantages and disadvantages of various types of 3D scanning and digital equipment and basic technology. Optical 3D scanning and equipment calibration: master the technical characteristics of optical 3D digital scanning equipment in terms of accuracy and speed, clarify the importance of equipment calibration, and be familiar with the requirements calibration and digitization conditions. Universal method of scanning data processing: master the methods of scanning data processing such as de-noising, smoothing, and filling, and technology of hole recognition and model repair. Scanning model data processing and export: understand the requirements for scanning model data processing, and master the method of model data export Reverse modeling software and operation: be familiar with the basic knowledge of reverse modeling software, and be able to use the software for grid data packaging, hole filling, optimization processing. Reverse modeling method: master the method of reverse modeling for curved surface and entity. 3D modeling and assembly of digital software: the method of 3D modeling and 3D assembly of digital software. Related knowledge of comprehensive vocational ability: master the knowledge of comprehensive vocational ability to the job.	Concept of data acquisition Concept of contact data acquisition method Concept of non-contact data acquisition method Concept of fault data acquisition method

Table 4 (*continued*)

No.	Theoretical knowledge points	Theoretical knowledge points	The relevant knowledge described in the corresponding skill criteria
3	Understand the role and significance of motion simulation and stress analysis in digital design Understand the link between motion simulation and stress analysis Be able to use motion simulation to calculate dangerous points and corresponding loads of parts in motion Be able to export the corresponding conditions of key parts at the dangerous point to the stress analysis for design inspection, and output the analysis report	Principles, types and relevant application knowledge of mechanical transmission Design knowledge of mechanical transmission structure Knowledge of mechanical connection design Knowledge of mechanical drawing Quality, strength and application knowledge of metal and non-metallic materials Generation, view setting, editing and annotation methods of part engineering drawing of 3D software Scenario, light source setting and rendering output method of 3D software part rendering picture Animation production method for assembly or disassembly of 3D software Finite element analysis method for parts by 3D software Knowledge of comprehensive professional competence	Mechanical drawing and related knowledge of 3D digital scanning equipment: master the knowledge of mechanical drawing, be familiar with the operation principle of 3D digital scanning equipment, understand the advantages and disadvantages of various types of 3D scanning and digital equipment and basic technology. Optical 3D scanning technology and equipment calibration: master the technical characteristics of optical 3D digital scanning equipment in terms of accuracy and speed, clarify the importance of equipment calibration, and be familiar with the requirements for calibration and digitization conditions. Universal method of scanning data processing: master the methods of scanning data processing such as de-noising, smoothing, and filling, and the technology of hole recognition and model repair. Scanning model data processing and export: understand the requirements for scanning model data processing, and master the method of model data export. Reverse modeling software and operation: be familiar with the basic knowledge of reverse modeling software, and be able to use the software for grid data packaging, hole filling, and optimization processing. Reverse modeling method: master the method of reverse modeling for curved surface and entity. 3D modeling and assembly of digital software: master the method of 3D modeling and 3D assembly of digital software. Related knowledge of comprehensive vocational ability: master the knowledge of comprehensive vocational ability related to the job.

Table 4 (*continued*)

No.	Theoretical knowledge points	Theoretical knowledge points	The relevant knowledge described in the corresponding skill criteria
4	Basic concept and typical industry application of additive manufacturing (3D Printing) technology General flow of 3D printing Processing before 3D printing Basic operation method of 3D printer	3D printer debugging (setup and connection, printer calibration) Selection of 3D printing process method and formulation of printing process flow Usage of 3D printing slice software Setting of 3D printing slice parameters (printing quality parameters, filling parameters, printing speed, temperature parameters, support parameters, etc.) Methods for 3D printing and auxiliary equipment operation Common use troubleshooting of 3D printing equipment Post-processing method for 3D printing (taking part, removing support and polishing) Precision inspection (outline precision measurement, outline surface inspection, defect detection, etc.)	Type and application of 3D printing Basic operation of 3D printing equipment Analysis and elimination of common faults of 3D printing equipment
5	Basic concepts of reduced material manufacturing and computer assisted manufacturing Numerical control processing programming process of Fusion 360 software manufacturing module The Fusion 360 software manufacturing module outputs process codes for simple parts Basic operation methods of numerical control equipment Basic concept and typical industry application of additive manufacturing (3D Printing) technology General process of composite processing of increase/decrease materials	Knowledge related to tooling fixture design Basic knowledge of mechanical drawing Knowledge of tolerance fits and manufacturing accuracy classes Usage of 3D printing slice software Setting of 3D printing slice parameters Use of 3D printing equipment 3D Printing Post-processing Method Formulation of NC process route Basic knowledge of NC machining and equipment use	CAM software application Basic operation methods of CNC milling machine Detection and inspection methods of mechanical parts Basic measurement methods of mechanical parts

6.2 Skill practice

6.2.1 Digital modeling expression and optimization of industrial design

The learning tasks for digital modeling expression and optimization of industrial design are detailed in table 5.

Table 5 Learning tasks for digital modeling expression and optimization of industrial design

No.	Name of learning task	Class hour	Learning goal	Skill points
1	Knowledge of industrial design technology	2	Understand the concept and development of industrial design technology Familiar with the characteristics of industrial design technology Get familiar with the drawings of industrial design products	Correctly analyze the structure and size of each part of the part according to the given product part drawing by using the feature analysis method Understand the 3D structure of parts through plan view Determine the dimension, process and other information of parts and components by marking information Skillfully use views, sectional views, sectional views and other methods to express the shape of parts Select the appropriate expression method according to the structural characteristics of the parts The simplified painting method specified in the national standard will be used
2	Understand design methods	2	Understand the concepts of bottom-up and top-down design methods Understand the characteristics and applications of bottom-up and top-down design methods	Formulate feasible top-down overall design scheme according to product characteristics Prepare relevant top-down design scheme based on existing parts and standard parts
3	Modeling design of piston pneumatic motor parts	10	Master drafting methods and common tools Understand the role of sketch constraint and master common tools for sketch constraint Understand the concepts and roles of draft features, placement features, and location features Can create part models from sketches, feature tools	Use computer plotting software tools to draw various 2D graphics Perform a feature analysis based on the given product part drawing and plan modeling steps Draw accurate 2D sketches required for modeling Select the appropriate modeling tools to create a simple solid shape of the part
4	Assembly design of piston pneumatic motor components	10	Master the process of component assembly Understand the meaning of each constraint tool and their respective applications Understand the meaning of each connection tool and its application Understand the role of standard parts library and resource center Restraint and connection tools can be used to complete component assembly Can load standard parts through resource center	Install the parts in the environment of the parts, and reasonably set the fixing constraints of the parts according to the characteristics of the parts Use part movement and rotation tools in the part environment to adjust part position or placement angle Restrict the degree of freedom of the part in the component with the Positional Restraint Tool Specifies how the part will move by means of the motion restraint tool Position and motion relations of parts and components are specified by connecting tools Demonstrate motion by driving constraints or coupling relationships

Table 5 (*continued*)

No.	Name of learning task	Class hour	Learning goal	Skill points
5	Top-down modeling design of piston pneumatic motor	10	Understand the meaning of "top-down" design concept Understand the design process and application of multi-entity modeling Understand the application process and application of adaptive technology The ability to create associated parts using multi-entity modeling techniques Be able to create related parts using adaptive technology	Top-down design concept, capable of formulating feasible top-down overall design scheme according to product characteristics Be able to develop relevant top-down design scheme based on existing parts and standard parts
6	Knowledge derived design	4	Understand the concept of derivative design Understand industry applications of derivative designs	Understand the component optimization design idea, application situation and basic workflow of derivative design method Prepare part optimization design scheme according to optimization requirements
7	Derivative design of piston pneumatic motor bracket parts	12	Master the general process of derivative design. Constraint conditions such as reserved area, obstacle area, load, constraint, target, processing method and material will be added. Pre-derivative design checks and preview are performed and constraints can be adjusted according to prompts. Derived designs are run and results are viewed, and each design result can be compared and judged Derived design results can be exported and edited	Derived design conditions for component optimization are set using retention areas, barrier areas, starting shapes, loads, constraints, design goals, manufacturing conditions, material tools. It can select the optimal design results of the required parts according to the needs and conduct the model export Based on the given design and manufacturing conditions, the derivative design tools can be used to complete the optimal design of components and replace the original component design scheme, so as to reduce the number of parts, achieve lightweight design and reduce the product cost The resulting components are exported and processed as necessary
8	Two-dimensional engineering drawing design of piston pneumatic motor parts and assembly	4	Understand the relationship between engineering drawings and component model parameters and master the editing methods Master the methods for creating various contents of engineering drawings Master the creation process and method of part drawing and assembly drawing	Generate corresponding 2D map according to 3D model Can use drafting software to complete various part representations The component assembly drawing will be completed using the drawing software
9	Effect picture design of piston pneumatic motor	4	Master the general process of rendering Defined material and appearance conditions are added Select the rendering scene environment and add local light source conditions	Appropriate scene style and light source style can be selected in the rendering module Set appropriate rendering parameters and output product rendering

Table 5 (*continued*)

No.	Name of learning task	Class hour	Learning goal	Skill points
9	Effect picture design of piston pneumatic motor	4	The camera and its viewing angle bits are created, adjusted and edited Output rendering and set corresponding parameters	
10	Animation design of working principle of piston pneumatic motor	12	Understand the working principle, function of animation and production process Animation time, speed and other parameters can be set through animation time axis Component actions can be set through tools such as constraint animation and parameter animation The fade out display setting for some parts during animation is performed The camera animation tool sets the viewing angle and direction in the animation	It can output the working principle of the product to display animation in the component rendering environment
11	Animation design for disassembly and assembly of piston pneumatic motor	12	Master the general process of making disassembly animation Component disassembly is simulated by adjusting part positions The camera will be set to adjust the viewing angle and scale during disassembly and assembly Improves the visual appeal of the disassembly animation by setting part opacity The animation parameters are fully managed via the timeline	Animation of product assembly and disassembly process can be output on the basis of presentation view
12	Understanding quick design tools	6	Understand the meaning of parametric design, be able to set model parameters and establish correlation between parameters Understand the role of the iPart tool and be able to create part families (libraries) with the iPart tool Understanding the role of the iFeature tool, you can quickly create reusable features using the iFeature tool Understand the role of the iLogic tool to control part features by establishing rules Understand the role of the derived part tool and be able to use the derived part method to create the required part models through the Boolean operations between parts	The product model will be built with a top-down design scheme using a multi-entity style Be able to name, rename, edit and modify an entity or part created by multi-entity modeling

Table 5 *(continued)*

No.	Name of learning task	Class hour	Learning goal	Skill points
13	Quick design of parts of piston pneumatic motor	6	Understand the role of design accelerators and be able to use design accelerators to create common items such as gears Understand the role of structure builder and be able to create metal structures using structure builder Understand the function of welding module and be able to use welding tools for welding operation	Capable of generating corresponding parts and component documents from multi-physical parts The ability to create associated sketches in an assembly using adaptive techniques
14	Three-dimensional wiring design of automatic production line	4	Understand the significance of 3D wiring in the design of mechanical and electrical equipment, and master the design process of 3D wiring The corresponding connection points of electrical elements can be connected through wires and cables The creates a wire harness segment and is able to route the lead using the routing tool Cables are routed in wire harness sections	The ability to use adaptive techniques to create associated features in a ligand
15	Three-dimensional piping design of automatic production line	4	Understand the significance of 3D piping in equipment and mechanical system design Hard tube, bend and hose laying in 3D piping environment	Be able to create a part with an association using adaptive technology and set the validity of the association as needed
16	Dynamic simulation and stress analysis of piston pneumatic motor	6	Understand the role and significance of motion simulation and stress analysis in digital design Understand the link between motion simulation and stress analysis Be able to use motion simulation to calculate dangerous points and corresponding loads of parts in motion Be able to export the corresponding conditions of key parts at the dangerous point to the stress analysis for design inspection, and output the analysis report	It can transform assembly constraints into motion connection relations Product movement can be simulated by adding driving conditions Draw the motion path of key parts or key points as required, or obtain key information such as speed
Total hours		108		

6.2.2 Reverse design and Improvement

The learning tasks for reverse design and improvement are detailed in table 6.

Table 6　Learning tasks for reverse design and improvement

No.	Name of learning task	Class hour	Learning goal	Skill points
1	Understanding reverse technology	2	Understand the reverse design concept Understand the reverse design operation process Understand the reverse design application field	The gauge will be used to collect data from the model Capable of installing 3D scanners The 3D scanner will be used to collect data from the real product
2	3D scanning data acquisition and pretreatment of plaster Statue	12	Understand data acquisition methods using 3D scanning in reverse design Understand the working principle of 3D scanner and the operation process of supporting data processing software Capable of installing 3D scanner and collecting data of product in various ways Model fusion and other processing can be carried out for multiple acquired data files.	The 3D scanner will be used to acquire the point cloud data of the measured model through multi-angle acquisition information
3	Personalized design of spectacle frame based on reverse design method	10	Understand the significance of reverse design for digital product design Master the process of model reconstruction and innovative redesign with 3D design software Individual product design based on 3D scanning data	The point cloud data obtained in the data acquisition stage will be subject to substantiation processing
Total hours		24		

6.2.3　Digital manufacturing of parts

See table 7 for learning tasks of digital manufacturing of parts.

Table 7　Learning tasks for digital manufacturing of parts

No.	Name of learning task	Class hour	Learning goal	Skill points
1	Reduced material fabrication of disc cover parts of piston pneumatic totor	10	Understand the basic concepts of reduced material manufacturing and computer assisted manufacturing Master the NC processing programming process of the manufacturing module of Fusion 360 software The production code for simple parts is output using the Fushion 360 Software Manufacturing Module Understand the basic operation methods of numerical control equipment	Select proper machining equipment and auxiliary tools such as machine tools, cutters and fixtures according to product drawings and process requirements. Operate numerical control machine tool or traditional machine tool to reduce material of parts, and program or adjust.

Table 7 *(continued)*

No.	Name of learning task	Class hour	Learning goal	Skill points
2	Additive manufacturing of piston pneumatic motor bracket parts	10	Understand the basic concepts and typical industry applications of additive manufacturing (3D printing) technology Understand the general process of 3D printing Can use pango software to complete 3D printing preprocess Understand the basic operation methods of 3D printer	Determine the way and parameters of 3D printing according to the characteristics of parts Operate 3D printing equipment to make part rough Complete consumable installation of 3D printer, common fault analysis and troubleshooting, etc
3	Material increase and decrease composite processing of piston pneumatic motor bracket parts	8	Understand the basic concepts and typical industry applications of additive manufacturing (3D printing) technology Master the general process of composite processing of increase and decrease materials Capable of manufacturing the piston pneumatic motor bracket with the method of adding and reducing materials	Processing requirements and process route planning: able to analyze the structural and precision requirements that need further precision machining based on component functions and assembly requirements; Clarify the cutting process route based on the characteristics of the processed parts. Design and production of fixtures and jigs: Able to design necessary auxiliary fixtures and jigs according to the processing route, and use additive manufacturing and other methods to ensure the smooth implementation of the processing process. Writing and executing machining programs: Able to use CAM software to write machining programs according to the process route, and use CNC milling machines to carry out subtractive manufacturing work using the programs output by CAM software. Workpiece processing and tooling use: Able to use auxiliary tooling fixtures to complete the processing of various surfaces of the workpiece. Workpiece quality inspection: Measure the surface of the workpiece to ensure that all processing requirements are met.
Total hours		28		

7 Teaching implementation

7.1 Teaching organization and teaching method

7.1.1 Teaching organization

This curriculum adopts the action oriented teaching concept in the real or simulated working environment, focuses on the principle of combining theory and practice of industrial design technology contest curriculum, and gradually improves students' industrial design technology skills and problem solving ability through systematic curriculum arrangement, from basic theory explanation of industrial design technology to practice links such as industrial design digital modeling expression and optimization, reverse design and improvement, and digital manufacturing of parts. Classroom teaching mode is adopted to ensure that each student can obtain sufficient guidance and practice opportunities. Meanwhile, interactive links such as case analysis and group discussion are integrated to enhance the fun and effectiveness of learning. The specific teaching organization is as follows:

a) Systematization of curriculum arrangement. The curriculum covers all aspects of industrial design technology, including core fields such as industrial design digital modeling expression and optimization, reverse design and improvement, and digital manufacturing of parts. Systematic teaching is conducted from theory to practice.
b) Outstanding practice links. Through practical project cases, students are involved in the whole process of industrial design, including design task acquisition, planning, virtual model construction, model map rendering, quality self-inspection, delivery acceptance and other links, so as to train students' practical operation ability and problem solving ability.
c) Classroom teaching. Classroom teaching mode is adopted to ensure that the teacher can pay attention to the learning of each student, give guidance and feedback in time, and ensure that students can fully master the knowledge and skills learned.
d) Rich interaction links. Integrate case analysis, group discussion and other interactive links to let students learn in communication and cooperation, enhance their team spirit and communication ability, and improve their ability to analyze and solve problems.
e) Real or simulated situation teaching. Teaching in real or simulated working situations enables students to better adapt to the needs of actual work and improve their practical ability and professional quality.

7.1.2 Teaching method

This curriculum adopts the action guiding teaching method, with the task as the guide, converts the representative work tasks in the industrial design technology contest into learning tasks, embeds the relevant knowledge points into each learning task, and imparts the relevant knowledge and skills through each learning task. What the task needs is said and practiced, and highlights the practical comprehensive professional ability training.

The teaching method of the curriculum focuses on the combination of theory and practice. Through theoretical teaching and case analysis, task-based learning and team cooperation, project driven teaching, extra expansion and independent learning, etc., students' industrial design skills and comprehensive quality are comprehensively improved.

a) Theory teaching and case analysis.
In the classroom, the teacher uses a systematic teaching method, through PPT presentation, vivid video materials explanation, combined with the classic cases of industrial design for in-depth analysis, guide students to learn from the project experience, enhance their understanding of industrial design. In this part, students will learn the core knowledge of industrial design technology, such as the concept, development history, characteristics, relevant terminology, reverse design concept, operation process, application field, role and significance of motion simulation and stress analysis, additive manufacturing (3D printing), reduced material manufacturing and basic concepts of computer assisted manufacturing, so as to help students establish a solid theoretical basis.
b) Teamwork learning.
Set a series of learning tasks according to the curriculum contents and practical application development links, such as industrial design digital modeling expression and optimization, reverse design and improvement, digital manufacturing of parts, etc. The students are divided into groups, each responsible for one task. During the task execution process, students need to give full play to the team spirit, cooperate with each other and solve the problems encountered. Students go through all process links of a specific task to comprehensively improve their ability to solve problems, innovative thinking and teamwork.
c) Task driven instruction.
Skill learning through practical involvement in industrial design specific tasks. Each task has clear objectives and requirements to complete specific design, model building, optimization and improvement, etc. within the specified time. In this process, trainees will encounter various practical problems that need to be solved through research and practice. Task-driven teaching methods allow students to master skills in solving practical problems and have a deeper understanding of industrial design.

d) Out-class expansion and independent learning.
Organize students to visit industrial design related enterprises, participate in relevant competitions or exhibitions and other activities, so as to let students experience the latest development trend and industrial application prospects of industrial design technology. At the same time, students are encouraged to carry out autonomous learning by providing rich online learning resources, recommending relevant books and websites. Through the combination of extra expansion and independent learning, students can have a deeper understanding of the latest progress of industrial design technology and improve their professional quality, learning ability and competitiveness.

7.2 Teaching resources

7.2.1 Overview of resources

Teaching resources of curriculum standard include site and facilities, hardware and software, teaching materials, technical support and teachers. These resources complement and cooperate with each other to form a complete teaching system, providing a strong guarantee for students' learning and practice.

7.2.2 Site and facilities

A special training room is required for the teaching of industrial design technology curriculum. It is an environment designed for technical training in industrial design, equipped with relevant design tools and equipment. Trainees can conduct modeling, rendering, testing and optimization of industrial design, gain practical experience through practical projects and improve technical skills. The training room provides technical support, practical projects and collaboration opportunities to help students master the core skills of industrial design and lay the foundation for entry into relevant industries or further research.

7.2.3 Hardware and software

Industrial design training room shall be equipped with advanced hardware and software to support relevant operation of industrial design. Hardware includes high-performance computers, 3D scanners, 3D printers, etc. In terms of software, the training room provides modeling software (such as Inventors, Fusion360, Crown CAD, etc.), rendering software (such as Inventors, Fusion360, etc.), reverse design software and relevant data analysis and test software.

7.2.4 Teaching material

Teaching materials serve as the cornerstone of instructional support and quality assurance, designed to meet competition requirements while balancing theoretical and practical components to form a comprehensive system. Core textbooks and lecture notes cover modules such as modeling and reverse engineering, complemented by real exam question analyses and practical operation guidelines. Standardized task sheets define objectives and assessments, while the "Practical Operation Manual" provides detailed instructions on equipment operation and software techniques. The case library includes award-winning competition entries and industry examples, and the resource library offers standardized models and other materials. Additionally, evaluation tools such as assessment records and judging criteria are provided, along with supplementary resources like academic journals and online materials to enhance teaching and self-directed learning.

7.2.5 Technical support and teachers

Technical support and faculty are pivotal to course implementation, forming a dual-support system. Technically, the team consists of 2-3 full-time staff for equipment maintenance and troubleshooting, collaborating with vendors for technical services, and inviting industry experts for specialized guidance. A real-time Q&A group chat is established online, along with technical documentation. The faculty is a "dual-qualified" team with a student-to-faculty ratio of at least 1:15, including both theoretical and practical instructors as well as corporate adjunct experts. Core teachers must possess relevant qualifications and experience, with continuous training to enhance their capabilities. An evaluation, incentive, and support mechanism ensures teaching quality.

8 Teaching evaluation

8.1 Evaluation objectives

The teaching evaluation of the industrial design technology curriculum aims to comprehensively test the students' mastery of the industrial design technology theory, skills and relevant standards and specifications, and evaluate the students' adaptability and ability level in the actual work post through a variety of evaluation methods. Based on the examination results, the trainees are divided into three levels: A, B and C, so as to provide scientific basis for the follow-up career development and post assignment.

8.2 Evaluation method

8.2.1 Content introduction

The teaching evaluation of industrial design technology curriculum combines process examination, curriculum design,project operation and examination results to comprehensively and objectively evaluate students' learning results and curriculum quality. These evaluation methods not only help students to understand their learning progress and existing problems in time, but also provide important basis for teachers to adjust teaching methods and curriculum contents, so as to continuously improve the teaching quality and learning effect of the curriculum.

It is suggested to adopt the method of combination of process evaluation and final evaluation for teaching evaluation. The process evaluation accounts for 40% - 60% of the total score, and the final evaluation accounts for 60% - 40% of the total score. The comprehensive professional ability of students shall be evaluated after the curriculum.

8.2.2 Process assessment and professional competence evaluation

Process assessment is the fundamental evaluation process of industrial design technology competition curriculum, which adopts a score system or grading system. By establishing clear scoring standards, it mainly tests students' learning attitude, participation, and daily homework completion in the classroom. The evaluation content includes classroom attendance rate, enthusiasm for questioning and answering questions, contribution in group discussions, and the quality and timeliness of homework submission.

Adopting the internationally popular COMET (Competency Oriented Model of Educational Targets) assessment method, the comprehensive professional abilities of athletes are evaluated through written tests. COMET starts from 8 key competency indicators, including intuitiveness, functionality, value orientation, economy, work process orientation, social acceptance, environmental friendliness, and creativity. Through 40 specific observation points, it comprehensively and meticulously assesses students. Through this evaluation method, students can have a more accurate understanding of their comprehensive vocational abilities in the field of industrial design technology, and based on this, their corresponding vocational ability levels can be assessed, providing important references for their future career planning and development.

8.2.3 Final exam and skill passport

Curriculum design or project assignments are the application evaluation stage of industrial design technology competition courses, requiring students to combine their learned knowledge to complete a specific industrial design project or research topic. The evaluation of course design or project assignments adopts a jury or review system, inviting industry experts or teacher teams for review to ensure the authority and professionalism of the evaluation. The evaluation content covers project selection, application of design methods, innovation of solutions, standardization of implementation processes, and display and evaluation of final results.

The practical performance is the final evaluation stage of the industrial design technology competition course tasks, which comprehensively tests students' understanding and mastery of course knowledge, skills, and methods. The evaluation of exam results adopts a percentage or grade system, and detailed scoring standards are formulated based on the exam outline and requirements to ensure fairness and consistency in the evaluation. The exam covers theoretical knowledge of industrial design technology, digital modeling expression and optimization, reverse design and improvement, digital manufacturing of parts, and other aspects.

At the end of the course, according to the assessment work plan, relevant experts will be organized to conduct a final assessment of the students. The assessment content of the skills passport exam closely revolves around the core skills of industrial design technology, including but not limited to digital modeling, reverse design, parts manufacturing, etc. Based on students' performance in the course learning process, such as process assessment and practical results, the students' skill level will be comprehensively recognized, and corresponding international skill passports will be issued. The specific assessment criteria refer to the "Skills standards for industrial design technology competitions" to ensure the authority and professionalism of the evaluation.

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