



Research on Engineering Project Process and Method that Applied Talents Should Master Under Intelligent Manufacturing Technology

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Abstract. With the application of 5G network technology and the popularization and improvement of information technology, many applications of industrial Internet of Things have been born corresponding to industrial technology. Almost every industrial field has its corresponding industrial APP, constantly approaching the direction of “Internet of Everything”. Engineering projects include a large number of intelligent manufacturing, artificial intelligence, industrial robots, automation project transformation, in this field, there is a special group of talents, that is, many higher vocational colleges and application-oriented undergraduate universities training engineering application-oriented talents. They are the core participants of the industrial Internet of Things and intelligent manufacturing industry, and they need to master the research methods and project process of engineering projects in the era of information and intelligence.

Keywords: Intelligent manufacturing · Engineering project · Application-oriented talents · Industrial robot · Artificial intelligence (AI)

With the popularization and improvement of information technology, 2G and 3G networks have developed to 4G and 5G networks. With the application of 5G network technology, many applications of industrial Internet of Things have been born. Almost every field has its corresponding industrial APP, constantly approaching the direction of “Internet of Everything”. In this field, there is a special group, that is, the engineering applied talents trained by higher vocational colleges and applied undergraduate colleges. They are core players in the industrial Internet of Things and intelligent manufacturing industry. The theoretical knowledge of such talents is not solid enough. Meanwhile, the growth of engineering application-oriented talents needs time to settle. They cannot systematically master the engineering application project process and lack in-depth understanding of the engineering project operation method. Application-oriented talents need to master the process of engineering projects and research methods of intelligent manufacturing projects.

1 Intelligent Manufacturing Engineering and Industrial Robots

1.1 Artificial Intelligence in Intelligent Manufacturing

In the dictionary, intelligence means “the ability to learn and solve problems”; Artificial intelligence is the ability to solve new problems, act rationally and act like people. It is the basic principle of intelligence research. It is the use of intelligent robots to simulate the thinking process of people, and it is the study of how to use intelligent equipment to complete the work that depends on human intelligence. Artificial intelligence is a strategic project for many countries. With the emergence of 5G signals, new mobile terminal technologies, big data, and IOT sensing technologies, a number of new smart needs and applications have been born, such as smart home, smart driving, smart city, smart economy, smart manufacturing, and smart medical care. At the same time, some new industries were born, such as human-machine hybrid enhancement, big data intelligence, autonomous intelligence, cross-media intelligence and so on [1] (Figs. 1 and 2).

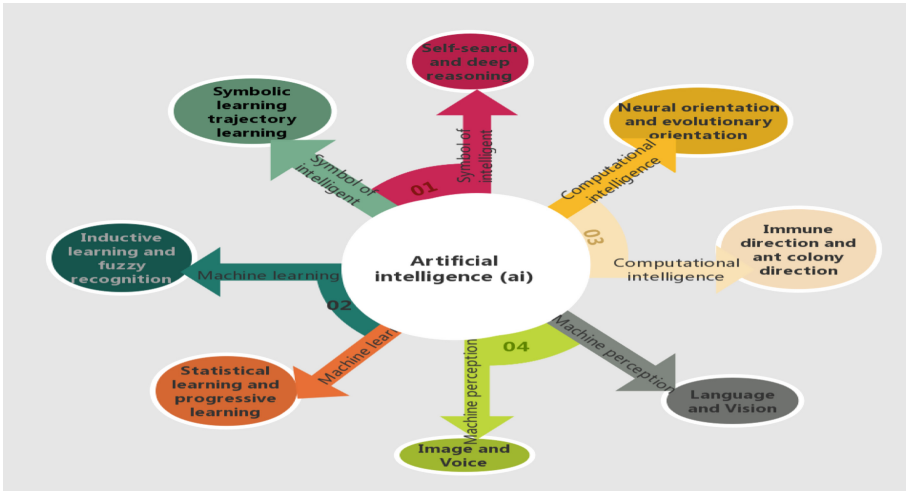


Fig. 1. Artificial-intelligence

Artificial intelligence changes the course of The Times. Carl Benedikt Frey and Michael Osborne of Oxford University found that “47% of American jobs could be replaced by machines”. Job automation and artificial intelligence “have a creative destruction impact” that will lead to huge reductions in the cost of employment and the loss of many jobs. The McKinsey GlobalInstitute concludes that “AI is driving social transformation that is 10 times faster, 300 times larger, and almost 3,000 times greater than the industrial revolution”. In 2019, the scale of China’s AI industry reached 34.43 billion yuan [2].

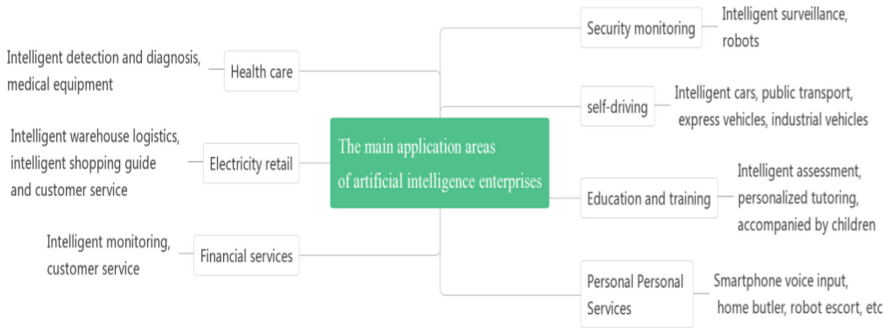


Fig. 2. The main application areas of artificial-intelligence

1.2 Industrial Robots in Intelligent Manufacturing

1.2.1 Advantages of Industrial Robots

The era of intelligent manufacturing is coming, and the robot industry is about to explode. In 1920, in “Rosum the Universal Robot,” Chapik described “a robot named Robert who looks like a man and acts like a man” (Czech for forced labor). Since then, the word “robot” and the Chinese word for “robot” have become popular. “Automation with human appearance or functioning like human”.

With the use of robots, intelligent manufacturing in automated factories eliminate simple and repetitive processes. The blowout of industrial robots will be applied in every process and every production line of “Made in China”. The application of industrial robots reflects the upgrading of China’s manufacturing industry. The use of industrial robots in factories can save labor costs, reduce personnel safety accidents, product specifications, improve production efficiency, etc. (Fig. 3).

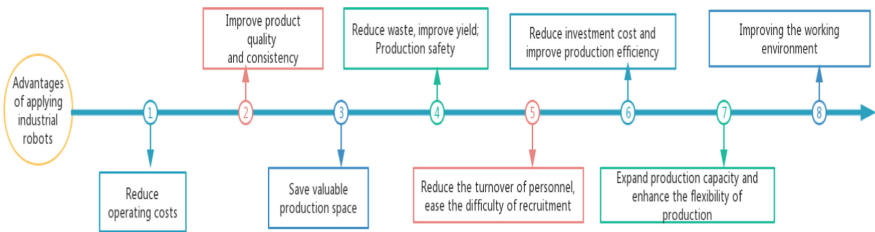


Fig. 3. Advantages of applying industrial robots

Generally, when a factory invests in an automated production line, the payback cycle is set to be 2–3.5 years. Currently, most local governments have a proper proportion of incentives for the purchase of industrial robots, which greatly speeds up the payback cycle [3] (Fig. 4).

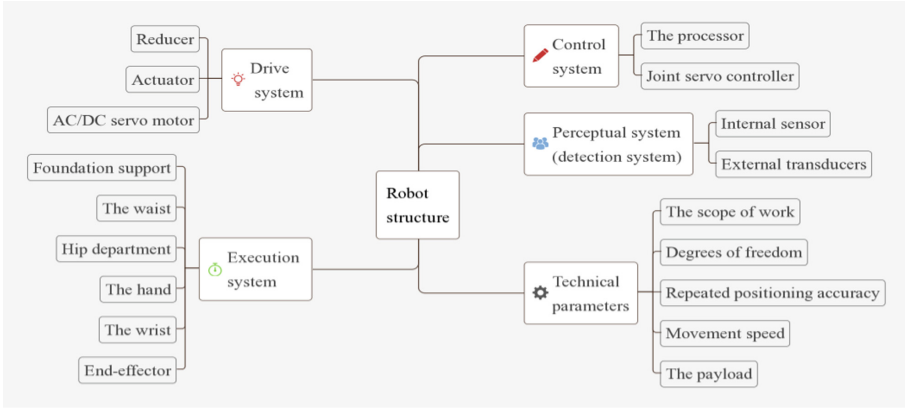


Fig. 4. Robot structure

1.2.2 Positions of Industrial Robots

Industrial robots are widely used in palletizing, painting, welding, handling and assembly. At present, the education structure of the personnel engaged in this position is: about 45% in technical secondary schools, 45% in junior colleges and higher vocational colleges, and 10% are undergraduate postgraduates.

Jobs	The specific work
The project manager	Based on industrial robot system technology, according to the manufacturing process of products, propose automation solutions and organize the implementation
System integration development engineer	Be able to complete the design and upgrade of robot workstation and automation line
Technical support engineer before and after sales	Can be engaged in industrial robot related mechanical and electrical equipment installation, programming, debugging, maintenance, operation and management work
Installation, commissioning and maintenance engineer	Knowledge of industrial robot principle, operation, teaching programming, reproduction and debugging

1.2.3 Development Status and Trend of Industrial Robot Enterprises

	Reducer	Servo system	Robot body equipment in the middle stream	Upstream component control equipment	Downstream system integration
Domestic listed company	Shanghai electromechanical, Qinchuan Machinery Development	Shanghai step, Huichuan Technology, Central China CNC, INVT	Xinsong Robotics, Bosch Holdings, Tianqi shares, Avea shares, Jasic robotics, Central China CNC, Huachangda, Superstar Technology, SCİYON Automation	Shinmatsu robot, Shanghai step, Cixing shares	Xinsong Robotics Co., Ltd., Bosch Co., Ltd., Tianqi Co., Ltd., Avea Co., Ltd., Jasic Technology Co., Ltd., Ruiling Co., Ltd., Huazhong CNC Co., Ltd., Huachanda Co., Ltd., Xingxing Technology Co., Ltd., Cixing Co., Ltd., Keyuan Co., Ltd.
Domestic non-listed companies	Green Harmonic, Nantong Zhenkang, Zhejiang Hengfengtai	Guangzhou CNC, Nanjing Eston	Anwei Eft, Guangzhou CNC, Nanjing Eston, Shanghai triowin, Dongguan Qizhi, Suzhou platinum automation	Guangzhou CNC, Nanjing Eston, Shenzhen googo	Anhui Efort, Guangzhou CNC, Nanjing Eston, Huaheng Welding Co., Ltd., Juyi Automation, Suzhou Platinum Electric, Huaheng welding

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	Reducer	Servo system	Robot body equipment in the middle stream	Upstream component control equipment	Downstream system integration
The foreign company	Harmonic, Nabtesco, Sumitomo	Luntz, Bosch Rexroth, fanuc, yaskawa, Panasonic, Mitsubishi, Sanyo, B&R, Siemens	ABB, Fanuc, Yaskawa, KUKA, Panasonic, Kawasaki, Nachi, COOMAU, Aidepu	ABB, Fanuc, yaskawa, KUKA, Panasonic, Nachi, Mitsubishi, B&R	ABB, Fanuc Yaskawa, KUKA

2 Process of Intelligent Manufacturing and Industrial Robot Engineering Application Projects

2.1 Intelligent Manufacturing and Industrial Robot is a Comprehensive System Engineering

The most important characteristic of the system is the integrity of the system. Engineering project system also has the characteristics of openness (accessibility), fragility (a poor system is invaded and may face collapse) and robustness(the system may lose its original function in the face of input error, interference and invasion). The project team should have a correct understanding of this [4] (Fig. 5).

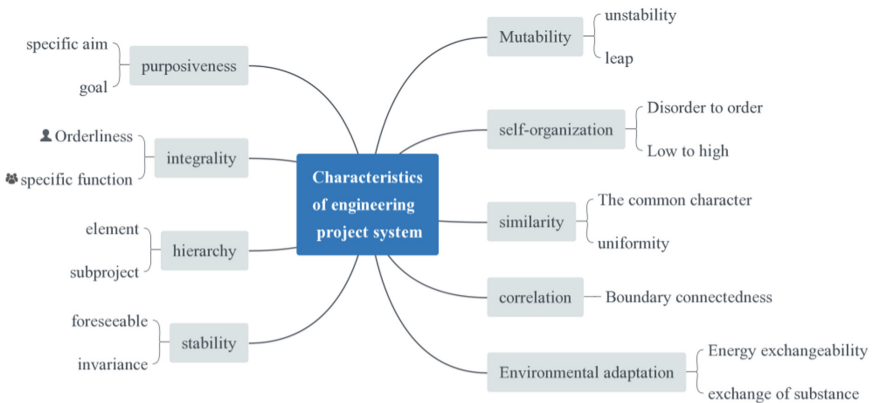


Fig. 5. Characteristics of engineering project system

2.2 Current Characteristics of Intelligent Manufacturing

Since the 1990s, technological innovation and the popularization of the Internet have been prominent features of the global economy and society. Each country in cyberspace, mobile Internet, intelligent manufacturing, cloud computing, industrial Internet, big data, information security and other comprehensive competition, intelligent manufacturing industry has become the strategic point of the core competitiveness of each country. Application-oriented talents of intelligent manufacturing should master the various processes of organizational structure, management process, production skills and production tools in the production process. At the same time, it is urgently needed that these personnel know all-round technology and management, and can know the application-oriented talent team from project initiation to project completion. Application-oriented talents have a comprehensive grasp of the five process groups that need project management, namely “Plan -- Do -- Check -- Act”. The loop is linked by results, which form the basis for the next step.

Intelligent manufacturing engineering projects have large investment, long construction cycle and high risk, which are more difficult and complex than general technical projects. In engineering acceptance, engineering projects need to be modified and maintained constantly with the change of external factors. At the same time, intelligent manufacturing engineering projects use a certain number of years, the upgrade will be upgraded, the elimination will be eliminated, with the new system to replace the old system is certain. Engineering application-oriented talents need to understand the process of engineering projects at each stage, which is called the life cycle of intelligent manufacturing engineering projects. The life cycle of intelligent manufacturing engineering includes the following figure (Fig. 6):

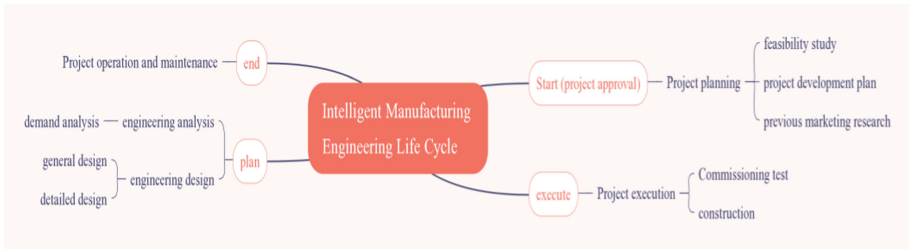


Fig. 6. Intelligent manufacturing engineering life cycle

2.3 Overall Process of Intelligent Manufacturing

The whole process of intelligent manufacturing is divided into four stages, namely, project approval, development, operation and maintenance, and extinction. Design methods include: structured approach (dividing the project life cycle into planning, analysis, system design, implementation, maintenance, etc.) and prototyping approach (clarifying the functional requirements of the system and determining the system boundary) [5] (Figs. 7, 8 and 9).

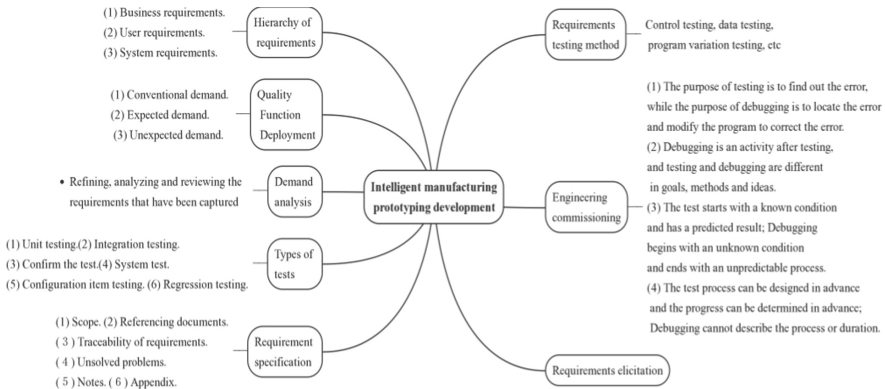


Fig. 7. Intelligent manufacturing prototyping development

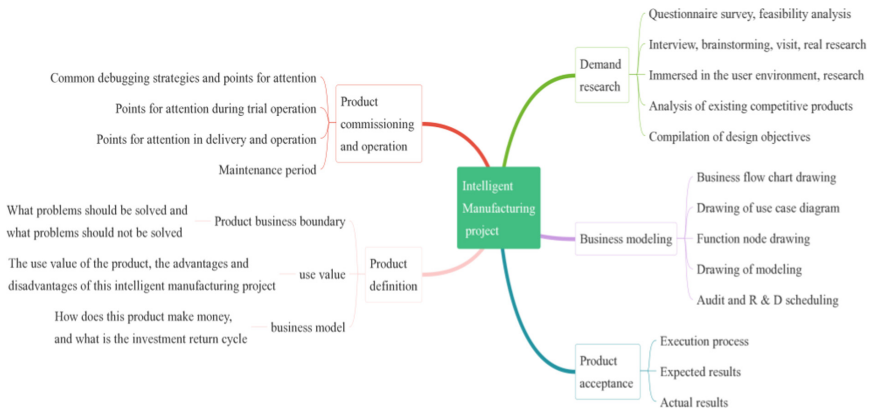


Fig. 8. Intelligent manufacturing project

2.4 Theoretical Design Process of Automatic Production Line

Automation engineering projects often use Siemens system knowledge, the following S7-1200 design as an example: control system design principles and processes.

Any control system system design, first of all need to do a comprehensive understanding of the object, and on a deep analysis of the technological process, equipment, etc., to seriously study the function of the system requirements to achieve and, the performance indexes of the control scheme is determined, so as to guarantee the quality of products, improve product yield, saving energy and reducing consumption, improve production efficiency and improve the management level of purpose [6].

(1) Design principles

In general, the following principles should be followed.

A. Stable operation, safe and reliable

The design of the control system can be in the external disturbance, system parameters in a certain range of long-term stable operation, in the whole production

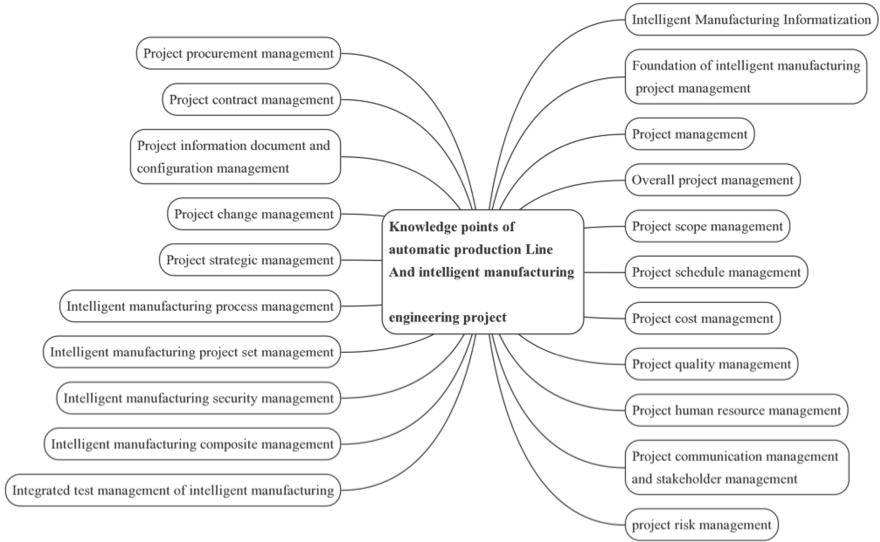


Fig. 9. Knowledge points of automatic production Line And engineering project

process, to ensure the safety of people and equipment, is the most basic requirements of the control system. Therefore, the device selection, system design and software programming must be considered comprehensively. For example, in the hardware and software design, not only under normal conditions, to ensure that the system can run reliably, but also to ensure that under abnormal conditions (system power down, misoperation, parameters out of limit, etc.), can work correctly and reliably.

B. Meet the requirements

Satisfying control requirements is an important principle in designing control system. Designers should go deep into the site before the design, understand the collection of site data, production process, access to information related to the system at home and abroad, maintain close cooperation with the site engineering management personnel, technical personnel, operators and consult the specific site conditions, joint research and design.

C. Economical and practical, easy to expand

Under the premise of improving product quality, output and work efficiency, the design should be optimized to ensure that the benefits of the project can be continuously expanded and the project cost can be effectively reduced at the same time.

In order to meet the control system can continue to improve and improve, in the design of automatic control system to consider the future upgrade, in the choice of PLC models and expansion modules, leave a certain margin.

(2) Design process and design content

- Complete the design and determine the control scheme according to the production process and analysis control requirements.
- Select input and output devices.
- Select the PLC model.

- Assign input and output of PLC and draw external hardware wiring diagram of PLC.
 - Write programs and debug them.
 - Design control cabinet and install wiring diagram.
 - Compile design specification and operation specification.
- (3) Design steps
- A. Technology analysis
- After receiving the design task, first understand the site conditions, working characteristics, technological process, working process and control requirements of the controlled object, coordinate the reasonable division of the system, design the conversion conditions between the control processes, and draw the flow chart or function diagram [7].
- B. Choose the right PLC model
- The selection of models is mainly considered as follows: the selection of functions (to meet the needs of system functions), the determination of I/O points (to have a certain amount of reserve) and the estimation of memory.
- C. Assign I/O points and draw a hardware wiring diagram
- D. The program design
- According to the production process requirements, draw the flow chart or function diagram, and then design the program for debugging and modification, until the control requirements.
- E. Control cabinet design and site construction
- F. Control system overall debugging
- G. Compile technical documents

3 General Research and Method of Engineering Technology

3.1 Basic Process of Engineering Technology Research

- A. Application research: under the guidance of basic research theory, the research on technical basis and technical principle is carried out in order to obtain new products, new processes, new materials and new methods, with the focus on solving theoretical and feasibility problems in engineering design of technology application.
- B. Technological development: using new materials, establishing new devices, designing new processes, producing new products and providing new services. The development results are samples, prototypes, device prototypes and technical documents [8].
- C. Engineering design: to produce the final product as the object, solve all the process and technical problems from the prototype to the actual production, to meet all the needs of formal production.
- D. Engineering construction: for the actual production operation to establish hardware workshop, production lines, equipment, auxiliary facilities and software organizational structure, technical standards, production plans, personnel allocation, etc.

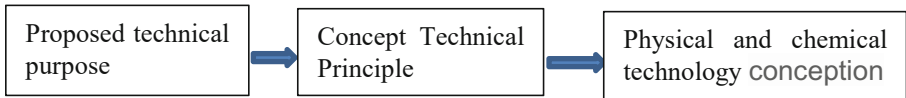
- E. Production operation: it is necessary to timely discover and solve various technical and non-technical problems in the production process in accordance with the continuity or dispersion characteristics of product production to ensure the normal operation of production.
- F. Technical service: it is a new requirement for engineering and technical personnel under the condition of market economy. It is of great significance for producers to improve product quality, improve product performance and develop new products.

3.2 Main Stages of Engineering Technology Research

- A. Technical planning stage: demand establishment, development prediction, purpose setting and consequence assessment.
- B. Technology invention stage: it is the basic idea for the technology creator to solve the problem.
- C. Technical design stage: it should be creative ideas obtained by the specific price of the vision.
- D. Development and implementation stage: after the evaluation of the technical design scheme, the technological creation enters the development, experiment and technical appraisal of the physical and chemical form.

3.3 Invention and Creation Methods of Engineering Technology Research

- A. The general process of engineering technological invention



It is pointed out that the purpose of technological research is the root of invention, and whether the purpose is appropriate or not directly affects the success or failure of subsequent invention. The principles of architecture technology are central to technological invention. The formation of technical principles depends on the engineering and technical personnel’s existing natural scientific knowledge and original technical practice experience and is proposed through the inventor’s innovative thinking. The conception of physical-chemical technology is the technical entity (such as sample and prototype) that is transformed into the physical form through the way of technical practice.

Common types of technical rationale ideas (Fig. 10).

3.4 Design Experiment Method of Engineering Technology Research

- A. Design method of engineering technology
 - Experience design period: an engineering product is designed by craftsmen based on the experience and knowledge accumulated in long-term production practice without complex theoretical calculation.

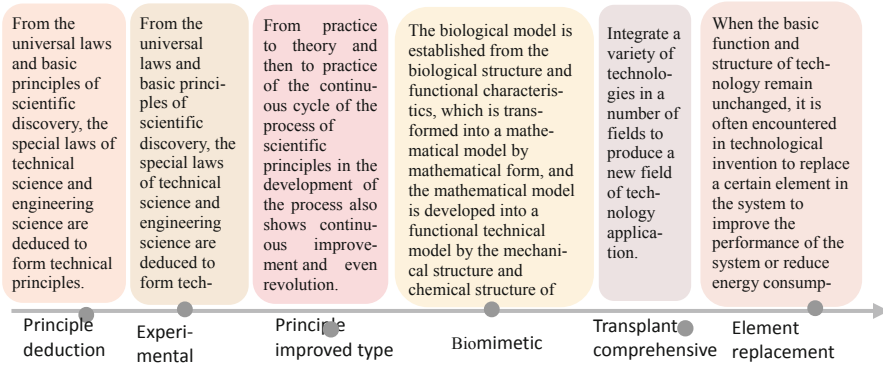


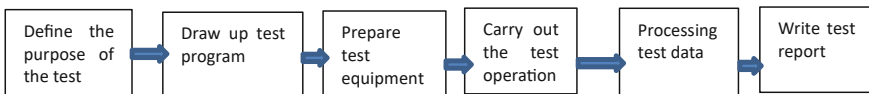
Fig. 10. Common types of technical rationale ideas

- B. The concurrent design period of experience and theory: technical design is in the parallel state of experience plus theory.
- C. The period of modern design: after the Second World War, the integrated development of science and technology gave birth to a new period of modern design, and the use of mathematical language and models greatly improved the scientific nature of design.

General methods of engineering technology design:

- (1) Form design method, from the existing technical means, technical information to find solutions to the problem.
- (2) System design method, the use of the concept and principle of the system, elements and the relationship between elements, design an optimal program.
- (3) Function value analysis and design method, considering the function of the object in the design, so as to optimize the function and economic effect.
- (4) Probability design method, the use of mathematical statistics to deal with the design data containing uncertain factors, can make the designed products to meet the given reliability indicators.
- (5) Optimal design method: based on the mathematical optimization theory, select the design variable values to obtain the best design scheme.

Basic procedure of engineering test:



4 Conclusion

In this paper, from the artificial intelligence in intelligent manufacturing, industrial robots in intelligent manufacturing, classification, development status and the current development of industrial robot companies, through the actual application example of automation project, the project process of intelligent manufacturing engineering project is studied, and finally the project process of intelligent manufacturing is proposed. The general research method and process of engineering project are put forward. It provides a useful exploration for application-oriented engineering and technical personnel to participate in project operation and management.

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