# Methods of Organizing and Implementing Comprehensive Practical Training in Machine Manufacturing and Evaluation of Teaching Performance

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**Abstract:** In response to the practical training approach and needs of the trinity of comprehensive mechanical manufacturing practical training, the organization of practical teaching was established, along with five integrated points in the organization and management process. Developed was a way of hierarchical administration for group internship activities. The internship performance evaluation standard is developed at last. It includes both internship content and internship management into the evaluation of internship performance and accomplishes many years of accident-free internship and factory operation.

## 1. Introduction

Mechanical manufacturing process practice, production practice, and mechanical manufacturing practice all contribute to the development of comprehensive practical training in mechanical manufacturing. It is one of the fundamental practical courses in mechanical engineering and plays a central position in the mechanical engineering curriculum. Training students to combine theory with practice and enhance their practical hands-on skills is a crucial component of practical teaching [1-2] [3]. Because to safety concerns, schools often permit students to see and comprehend the production process of components at the production site; however, few schools provide students hands-on experience [4-6].

There is a paucity of research on the teaching and reform of the material associated with thorough practical training in machinery manufacture at now. Relevant publications on educational reform are mostly based on study and analysis of each school's professional qualities. They have not yet examined the structure and management techniques of students' internships in businesses, and students' scores are mostly based on subjective instructor evaluations of their performance at the internship site and internship reports [7-9].

"Comprehensive Practical Training in Machinery Manufacturing" of Beijing University of Posts and Telecommunications adopts a three-in-one approach to practical training consisting of various factory visits (approximately 60% of the total class hours), lectures by engineers (approximately 20% of the total class hours), and hands-on practical training (approximately 20% of the total class hours). Although the emphasis of the practical training remains on the machinery manufacturing process, the internship has been broadened to encompass production organization and management, analysis of production equipment and production line layout, project management, and comprehensive applications. It focuses on applying acquired professional knowledge to assess and solve engineering challenges.

## 2. Teaching Content Planning for Comprehensive Practical Training in Machine Manufacturing

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As depicted in Figure 1, this practical activity plays a significant role in the mechanical engineering curriculum and serves as a "golden chain" connecting numerous professional courses, such as engineering graphics, theoretical mechanics, mechanics of materials, mechanics of materials, engineering materials, and other pre-foundation courses, as well as the subsequent basic mechanical manufacturing, mechanical principles, mechanical design, industrial Robotics, and Mechanical Innovations. It may link the academic material of many courses through practical training.

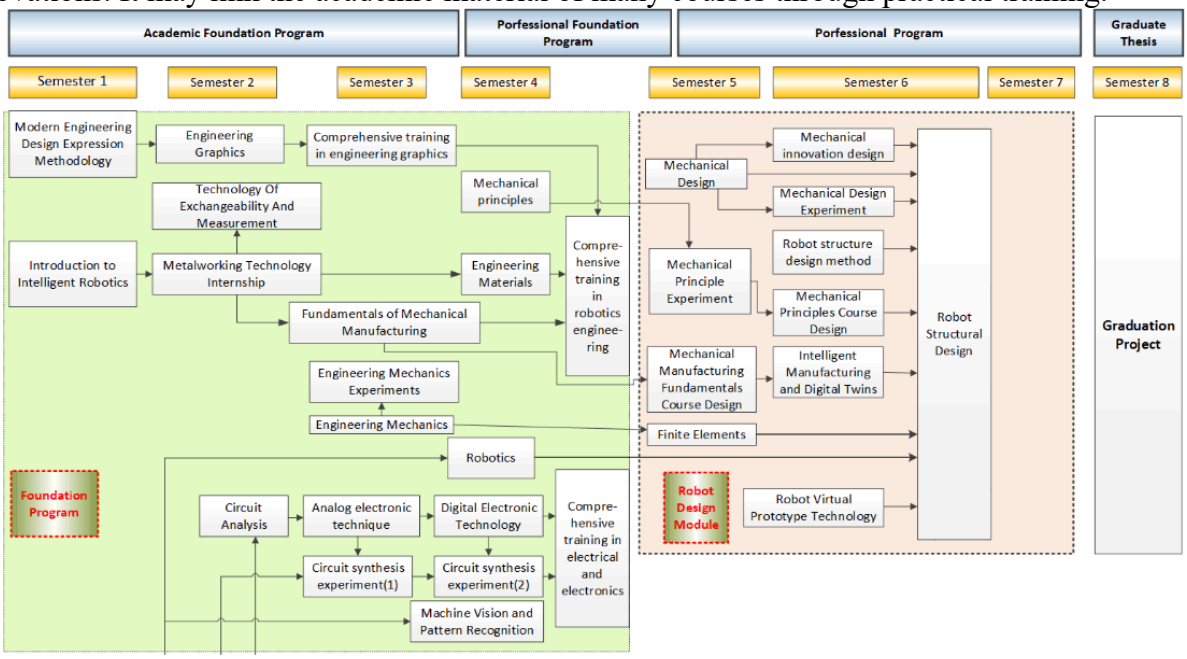


Figure 1. Map of Mechanical Engineering Courses of Beijing University of Posts and Telecommunications

During the implementation of the course, the students' understanding of engineering drawing, theoretical mechanics, mechanics of materials, engineering materials, and other courses is initially assessed through the problems encountered during the site visit, so that they can comprehend how the relevant knowledge is applied in practical engineering and how effectively it is applied. Second, it enables students to concentrate on comprehending and becoming acquainted with the basic machining procedures of typical components. Typical machining techniques include turning, milling, planing, grinding, and drilling. In addition, the processing techniques for common components such as gears, shafts, and boxes, as well as heat treatment techniques such as quenching, normalizing, and tempering. It also covers the assembly of ordinary electromechanical items, etc., to establish the groundwork for subsequent courses such as fundamental mechanical manufacturing and mechanical design. Thirdly, the course provides students with a broad understanding of the characteristics of various types of electromechanical products and their production organization methods, broadens their horizons, and lays a solid foundation for subsequent fundamental and specialized courses in mechanical manufacturing, mechanical principles, mechanical design, and mechanical innovation design. To ensure the safety and efficacy of the internship, the organization and management work must be performed meticulously.

In order to achieve these objectives, the Comprehensive Practical Training in Machinery Manufacturing at Beijing University of Posts and Telecommunications has planned the following teaching contents:

To comprehend the mechanical profession's cognitive knowledge and to assess the information

acquired in prior courses.

(1)Realization approach:

a) Visit many diverse enterprises to understand the design, production organization methods, and process equipment characteristics of various products in various industries, etc., as well as to comprehend the application of knowledge pertaining to mechanisms, structures, mechanical principles, materials, etc., and to analyze and summarize this information.

b) Emphasize on the similarities and differences between fixed point assembly, small batch assembly, and big batch assembly, as well as the similarities and differences between one-off manufacturing and mass production.

(2)Internship mode: on-site visit + explanation by on-site technicians.

Visiting enterprises belonging to different industries and of various types: Drag Research Power (gear processing and testing, mass production), Yituo Industrial Park (tractor assembly line including advanced means such as AGV vehicles, mass production), CITIC Heavy Industry (automation workshop, forging workshop, machining workshop, welding workshop, fire-fighting robots, etc., single-piece small batch production), Hechai Heavy Industry (diesel engine processing and assembly, single-piece (small batch production), Luoyang LYC bearing (automatic production line, machining workshop, mass production and small batch production), Longding Aluminum (aluminum profile production workshop, continuous mass production line), China Railway Equipment (shield machine assembly, single piece production) and many other enterprises (the specific internship may be adjusted according to the enterprise's production off-season).

1) Acquire the machining and assembly process of typical parts, such as gears, boxes, shafts and other typical parts and the assembly process of box-type components.

Realization approach: on-site visit + on-site technician explanation + engineer lecture + hands-on practice.

The engineers' lecture shows how what the enterprise engineers think for a practical engineering problem. A site visit for students immediately after the lecture can enhance the learning effect. The internship will arrange engineer lectures on machining process of typical parts and engineer lectures on assembly process of typical gearboxes, including gear machining, sand casting and practice, intelligent manufacturing, heat treatment, crankshaft machining, connecting rod machining, etc., together with corresponding enterprises to be visited. The visited enterprises include Tuoyan Power (gear processing, welding), Hechai Heavy Industry (case processing, crankshaft processing, case assembly), Luoyang LYC Bearing (bearing assembly and bearing parts processing), CITIC Heavy Industry (large gear and rotary processing, large parts forging, welding, etc.), China Railway Equipment (shield machine assembly), etc.

2) Practical operation. Comprehend the assembly process of common components and implement their assembly operations. The training must involve hands-on experience.

Realization approach: Moderately difficult disassembly and assembly of components or commissioning of equipment, requiring a degree of accuracy, but not so much precision as to surpass the students' capabilities.

Many practical exercises are scheduled, including the dismantling and reassembly of tiny motorcycle gasoline engines, the assembly and commissioning of 6-degree-of-freedom modular robots, and the mapping of molds. When ensuring that the severity of the exercises is suitable, it is possible to assure their safety.

3) Learn about business management in the mechanical industry.

Realization approach: on-site visit + lecture by corporate executives. It is possible to invite company executives to give lectures. The lectures cover various aspects of industrial enterprise organization and management, manufacturing information management and realization.

## 3. Implementation of the Organizational Approach

(1)The organization of practical teaching

While leading dozens of students to dozens of enterprises in the sector for internships, it is inevitable that we will confront a variety of particular circumstances and requirements. It involves

collective movement to accommodation, meals, accompanying things, epidemic prevention and control, and the management norms and regulations of many producers, all of which must be treated extremely carefully. Structured internship management is required to ensure the efficacy of internships and the safety of students. Thus, the administration and organization of practical instruction should be linked with the following:

① Combination of lectures by engineers and industry tours.Attempt to make the two events coincide in time and substance.Attempt to plan a factory tour during the day and an engineer lecture in the evening on the same internship topic.

② Site visits and practical activities are combined.The hands-on training's material is intended to be as pertinent to the purpose of the site visit as feasible.

③ Knowledge learning is combined with safety.It is crucial to pay attention to safety throughout the factory tour,and to encourage students to observe and remind one another to avoid mishaps during the site visit and practical exercises.It is vital to organize for 1-to-1 real-time escorts and reminders from stable and dependable students for students who are often unfocused and have a higher likelihood of experiencing issues during the internship.Instructors should also give extra attention to these pupils throughout the internship.

④ Combination of teachers and class committees.It is difficult for teachers to take care of a long line of visitors during a corporate tour.Therefore,it should have 2 teachers at either end of the line to lead and wrap up,with class members in the middle of the line to assist with safety reminders.

⑤ Balance of work and rest.Daytime visits or practical exercises,evening lectures by engineers,and nightly bedtime inspections by professors can help students maintain a regular schedule.They contribute to the security of the students'internship.Considering the duration and intensity of the internship,it is advisable to schedule one day of free time during the internship.

(2)Hierarchical organizational management of collective activities

Collective actions during the internship process need the effective and safe functioning of the entire team. As a result, organizational management is critical. The management of pupils should concentrate on the function of and trust in the class committee. The class committee's position and incentive should be fully exploited, and the instructor should undertake hierarchical management through the class committee.

The instructor and the class committee separated the students into several major groups based on their dorms; each large group had a leader; each large group was then broken into many secondary groups, and then cascaded down to 3, 4, etc., until each group had only 3 to 4 individuals. When a group activity is required, the instructor manages the class leader, the class leader manages the class committee, the class committee manages the large group leader, the second group leader manages the third group leader, and so on. Each person simply needs to handle a few others to keep the issue under control. It is effective, and steps may be put into place rapidly.

The hierarchical organization and management style is the fundamental guarantee for the accident-free internship of Beijing University of Posts and Telecommunications in the past ten years. It also allows the students to feel the importance of organizational management methods

## 4. Performance Assessment Criteria

The internship grades should, on the one hand, represent the students' mastery of the class information and, on the other hand, indirectly promote the students' compliance with the internship norms and regulations. As shown in Table 1, the total grade of Beijing University of Posts and Telecommunications mechanical engineering practical training internship = internship report grade (40%) + internship notes grade (40%) + internship discipline (20%).

Among them, the discipline of the internship can be implemented with a single veto system, i.e., if a student fails in a single discipline of the internship (refers to the development of a significant effect of disciplinary problems), he or she might be deemed to have failed the whole internship.

Table 1. Assessment criteria

<table>
<tr><th>Appraisal Sessions</th><th>Weights</th><th colspan="3">Assessment and evaluation criteria</th><th>Special cases</th></tr>
<tr><td>Internship Discipline</td><td>20%</td><td colspan="3">The evaluation will be made depending on the attitude and discipline of the internship. Excellent 18 to 20 points, good 15 to 17 points, medium 12 to 14 points, failing 12 points or less.</td><td rowspan="5">Those who do not obey the teacher's management, seriously violate discipline, affect factory-school cooperation or cause accidents will fail the whole course.</td></tr>
<tr><td rowspan="2">Internship Notes</td><td rowspan="2">40%</td><td>Typical part process modules</td><td>20 points</td><td rowspan="2">According to the situation of each module, there are 4 grades of excellent, medium and poor, corresponding to coefficients of 0.9, 0.8, 0.7 and 0.5 respectively.</td></tr>
<tr><td>Production equipment and management module</td><td>20 points</td></tr>
<tr><td rowspan="2">Internship Report</td><td rowspan="2">40%</td><td>Typical part process modules</td><td>25 points</td><td rowspan="2">According to the situation of each module, there are 4 grades of excellent, medium and poor, corresponding to coefficients of 0.9, 0.8, 0.7 and 0.5 respectively.</td></tr>
<tr><td>Production equipment and management module</td><td>15 points</td></tr>
</table>

## 5. Implementation Results

Students at Beijing University of Posts and Telecommunications have enthusiastically embraced the Comprehensive Practical Training in Machinery Manufacturing in recent years. The images, notes, and analyses of the previous year's internship procedure demonstrate the students' high regard for the internship. The efficiency of the organization's implementation techniques is demonstrated by ten years of internships and hands-on experience free of accidents.

Figure 2 On-site lectures and engineer presentations by teachers and corporate engineers

Figure 3 Tractor assembly line tour and shield machine assembly tour

Figure 4 Transmission disassembly and engine disassembly and assembly practice

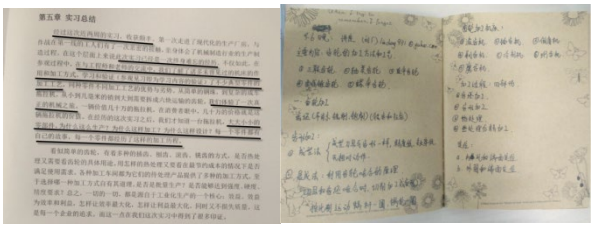

Figure 5 Example of notes and internship summary

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