# Contrastive Analysis of Mechanical Engineering Education between China and the United States

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**Abstract.** Nowadays, mechanic engineering education has significant influence to speed of the development of the technology and society. The well development of the mechanic engineering would bring country huge economic benefits and enhance military power, the rapid progression of mechanic engineering in China is given great attention. In the following passage, it would be focus on the comparison between mechanic engineering in China an United States. This paper makes contrastive analysis of the differences from aspects of education system, education syllabus, education structure, and students' learning abilities in China and the United States. Furthermore, this paper also analyzes plans and suggestions about development of mechanic engineering in china. It may be useful to understand the current situation of mechanic engineering education in China, and the difference of mechanic engineering education between China and the United Stated.

**Keywords:** Mechanical Engineering Education, contrastive analysis, education system

## 1 Introduction

In today's social environment of rapid development, how mechanical engineering develops has been a worldwide concern. The application of mechanical engineering has a great influence on the progress of human modern technology. Therefore, it is vital to develop mechanical engineering education. The improvement of mechanical engineering education quality can promote the development speed of the industry to a large extent, so as to make a great contribution to the advancement of human technology in the future. In today's world pattern, the United States is one of the most developed countries in the current mechanical engineering industry, while China is the fastest-growing nation in this field.

This paper makes contrastive analysis of the differences from aspects of education system, education syllabus, education structure, and students' learning abilities in China and the United States. Analysis in this professional education between these two countries can reflect the basic pattern, differentiation and future development direction of the current mechanical engineering education, and give relevant advice on the machinery education in these two countries.


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# 2 Analysis of Mechanical Engineering Education between China and the United States

## 2.1 Comparison of the basic curriculum system and educational syllabus

**The curriculum system and educational syllabus of mechanical engineering education in China.** In the *Syllabus for Qualification Test of Mechanical Engineer* (Trail/Version 2010) issued by the Chinese Mechanical Engineering Society, the Chinese Mechanical Engineering Society made eight requests for engineers, including being familiar with engineering drawing and tolerance fit, engineering materials, product design and manufacturing process, as well as the relevant professional laws and regulations, quality management systems, computer applications, and automatic manufacturing. It can be seen that this syllabus has made relatively comprehensive demands for Chinese engineers at present, involving almost all the basic knowledge necessary for engineers. At the same time, engineers are required to have some understanding of relevant laws and regulations, by which they can well learn about the matters that they need to follow in future work. Furthermore, this syllabus includes leading engineering technologies in the world, such as computer application and automatic manufacturing, reflecting that in order to catch up with the leading engineering technologies worldwide, the Chinese Mechanical Engineering Society has made some adjustments to education and examination outline. Moreover, these technologies are also the skills that engineers must master in the future.

According to the Mechanical Engineering Training Program (Undergraduate), the current undergraduate education program focuses on credit system, which mainly includes public basic courses, basic courses in discipline, professional courses, digital education courses and course practice. There are different proportions for the credits of each type of course, among which the highest is basic courses, followed by practice. Moreover, these two parts constitute the main content of courses. The basic courses include required courses and elective courses. The required courses include advanced mathematics and theoretical mechanics, etc., which are mainly general courses. The elective courses include advanced manufacturing technology and mechanical innovative technology, etc. The practice courses include internal and external practices, such as curriculum design of mechanical principles and production practices, etc. Off-campus internships are carried out in large state-owned enterprises such as FAW group corporation, etc.

Take the mechanical engineering education of undergraduates in Tsinghua University as an example. The professional education of Tsinghua University occupies 118 credits, which is composed of basic courses and major courses, as well as summer semester and time training. In the first part of basic courses, physics and mathematics account for the highest proportion. The second part of major courses are mechanics, fluid science and other courses highly related to mechanical engineering. The third part focuses on practice and internship [1].

**The curriculum system and educational syllabus of mechanical engineering education in the United States.** In terms of the mechanical engineering education in universities in the United States, the Accreditation Board for Engineering and Technology (ABET) proposed 11 training standards for undergraduate engineering education in total, including mastering mathematics, science and engineering and other theoretical knowledge of disciplines; grasping design, conducting experiment and analysis, and interpreting data; designing a system, spare part or process according to specific requirements; identifying, summarizing and solving engineering problems; applying necessary technologies, skills and modern engineering tools to tackle the practical and application issues on engineering. In the meantime, students are required to lead a multidisciplinary team; to understand their professional and ethical responsibilities; to make effective communication; to have a necessarily broad educational background to have an idea of the possible impact of engineering solutions against economic, environmental, social and global contexts; to understand the need for life-long learning and the ability to receive life-long education; to master the knowledge of contemporary issues to ensure that they adapt to the future employment and work [2].

American universities have formulated corresponding teaching schemes and syllabus according to the above training notes made by the ABET. The vast majority of American universities also use the credit system. However, each university has its own education focuses and programs.

The mechanical engineering education of University of Washington pays more attention to basic disciplinary knowledge and professional knowledge, while less attention to practice and internship courses. In this way, students can lay a solid theoretical foundation for their undergraduate study. They can also avoid poor foundation and narrow range of knowledge due to too many practical courses [3].

Clemson University in the United States adopts the pattern of small class teaching, and the laboratory course only has ten more students generally. Students can freely join different experimental groups. In the laboratory course, students first read the relevant materials, receive lectures, and then do the quiz to ensure that they effectively preview relevant knowledge and understand the basic principles of the experiment. After the quiz ends, the experiment starts, which is made of 3~4 students. After the experiment concludes, students are required to submit relevant experimental data and reports.

**Comparison of mechanical engineering education between China and the United States.** Similarities in the curriculum system of mechanical engineering education between China and the United States: (1) The curriculum frameworks between China and the United States are relatively consistent in general. The undergraduate education in both countries mainly adopts the credit system. (2) It is equipped with necessary basic engineering courses, diverse mechanical engineering courses and other relevant professional courses. (3) Based on the credit system, the course selection systems of the two countries require students to take general courses such as humanities, politics and language. Although these general courses are not much related to mechanical engineering, they can improve the comprehensive qualities and educational level of students more comprehensively. (4) The relevant practice and internship courses of the both countries can help students better transition to work in the future.

Differences in the curriculum system of mechanical engineering education between China and the United States: (1) The curriculum structures of American universities are different distinctively, while those of Chinese universities are same generally. For instance, in Purdue University in the United States, the mechanical engineering syllabus pays more attention to practice and internship, so more experiment courses are set. However, Washington University focuses more on the cultivation of basic knowledge, so the courses attach more importance to theoretical knowledge. Therefore, American students can choose different universities according to their abilities and needs. In China, the vast majority of mechanical engineering curriculum systems are relatively similar, which are divided into general courses, professional courses and internship, and work courses. Although students fail to choose a completely different curriculum system according to their own needs, a relatively uniform curriculum system can better standardize mechanical engineering education. (2) The evaluation standard and score proportion of total results in American universities are apparently different from the results evaluation in Chinese universities. In Chinese universities, the results of final exams and mid-term exams account for over 80% of the total results. In American universities, the results of final exams and mid-term exams only occupy about 50% of the total results [4]. The residual includes ordinary class participation, experimental performance, homework score, quiz score and attendance score, which ensures that students take each course, homework and experiment seriously rather than final exams and mid-term exams. In such doing, students can be dedicated to study throughout the semester, which guarantees their learning quality and changes their bad habit of studying hard only when final exams and mid-term exams approach.

### 2.2 Comparison of subject ability and learning situation of mechanical engineering students in China and the United States

The subject learning ability of undergraduate students majoring in mechanical engineering before the undergraduate study depends on senior high school curriculum system and enrollment difficulty to a large extent. Compared with the differences in the curriculum system structures of universities between China and the United States, there are more obvious differences in the curriculum systems of senior high schools between two countries.

In the Chinese senior high school curriculum system, the college entrance examination scores decide the undergraduate school where a student will study. Among the disciplines involved in the college entrance examination, three subjects, such as physics, chemistry and mathematics, have a great influence on students' learning the undergraduate course of mechanical engineering. Among the above three subjects, college entrance examination of physics include basic knowledge such as mechanics, thermology, electromagnetics, optics, and atomics, etc. Students use basic algebra to solve exam questions, which involves certain abilities of understanding, reasoning, analytical and comprehensive abilities, applied mathematics and experiment. College entrance examination of physics basically covers the basic subject knowledge required by mechanical engineering students in their future undergraduate studies. At the same time, the strict requirements of undergraduate universities for college entrance exam-

ination scores ensure that mechanical engineering students can completely master and apply these knowledge points.

In the American curriculum system, the courses are divided into required courses and AP (Advanced Placement) courses. Public school students only need to complete required courses, while private school students can select AP courses. The required courses include English, natural science, social science and mathematics. AP is a prerequisite course of American universities, among which the subjects related to mechanical engineering involve physical mechanics, physical electromagnetics, Physics 1, Physics 2, Chemistry, Calculus BC, calculus AB, and Statistics. Because students usually only learn 2 to 3 courses in a year, the knowledge points of each course are relatively less. For instance, AP courses include physical electromagnetics and physical mechanics. Besides, the subjects of AP course are similar to the knowledge points of university disciplines. For example, physical mechanics and electromagnetism concern the application of calculus to solving physical model. American senior high school students apply to schools by submitting documents, such as academic transcripts during the four high school years including AP scores, and sat or act scores. At the same time, American undergraduate applications place more emphasis on social practice activities and relevant competition results.

By comparing the high school curriculum systems of the two countries, it is found that Chinese high school students will do adequate practices to improve their ability of thinking about subject problems due to fierce competition and superior difficulty in the college entrance examination. Moreover, Chinese high school students have stronger ability for using subject knowledge, especially in science. However, since students need to spend most of their time doing exercises, their comprehensive practical ability is relatively poor. Despite the textbook adds experimental operation in recent years, students and teachers learn this part only to deal with exams. Meanwhile, there is a certain gap between the subject knowledge of Chinese senior high school courses and that of university courses. In terms of natural science, the subject knowledge of Chinese senior high school courses tend to be more classical theoretical knowledge, while less contemporary subject knowledge. Compared with Chinese students, American students do not have too many subject exercises because the AP exam is relatively easy. Students only need to reach 20% of all examinees in AP exams (Every course varies every year), who can get full marks. All American students have more time to take part in comprehensive practical activities. At the same time, the subjects of American AP course are closer to the subject curriculum of universities by adding more contemporary subject knowledge.

## 3 Analysis of the future plans for mechanical engineering education in China

It is vital to develop the future development strategy of mechanical engineering education. In China, the improvement of mechanical engineering education can better develop the manufacturing industry, while the manufacturing industry is an important industry in China. Therefore, it is especially important to promote mechanical engi-

neering education. The Minister of the Ministry of National Education proposed three main planning tasks. (1) Cultivate innovative mechanical engineers. Mechanical engineers need to have the creative spirit of surpassing the authority, self-leaning ability, leading professional knowledge and profound cultural deposits. (2) Colleges should strengthen case and experiment teaching and engineering training, and improve teaching quality. (3) Vigorously promote the cooperation between colleges and scientific research institutes, and enterprises [5]. From these three main tasks, it can be seen that our country attaches more importance to the professional practice ability of mechanical engineering students. In the past, the professional practice ability of Chinese students was relatively poor. Students will get more opportunities for professional practice according to the plan. Students will have more experiment courses, practical operation of problems and professional practice, which remedy the defect of mechanical engineering education in China to a large extent, more approaching to the education level of the United States and other advanced countries [6].

China also needs to adjust the defects of the education system by implementing relevant policies, publishing new educational syllabuses and other means. In the whole education system, there relatively lack effective practical courses and diversified courses. Especially the practical courses concern whether students can give reins to their subject knowledge in their future relevant mechanical engineering jobs. China's relevant education departments can appropriately reduce the pressure of subject tests, increase professional practice courses and improve the quality of professional practice courses, so that students can "truly" master knowledge [7].

The development of education in China is relatively imbalance. Major cities have superior educational resources, while relatively few in remote mountainous areas. However, in this case, China can try to start the sharing model of postgraduate education resources in local universities to enhance the utilization of resources [8]. In the meantime, China holds the world's leading 5G technology. China can share educational resources on the network platform with this technology, so that each city nationwide can enjoy roughly identical educational resources [9].

Finally, there is still a certain gap between the overall education methods, means and materials of mechanical engineering in China and those in the world's leading engineering colleges. Some scholars put forward that Chinese universities could adopt the method of educational resource grafting to allow students to receive the same advanced professional knowledge at home in a short time. Chinese universities could cooperate with foreign leading schools to introduce their teaching plans, teaching syllabuses, teaching methods and teaching management in the integrity [10].

## 4 Conclusion

According to the above analysis, China and the United States have relatively advanced mechanical engineering education systems. However, compared with the relatively complete system and adequate educational resources in the United States, China's mechanical engineering education has greater differences mainly in the diversity of course system, the proportion of scores in the course system, the distribution of course

types, the structure of senior high school courses, and the distribution of education courses. Since the reform and opening-up, mechanical engineering at home has had huge leaps. Nowadays, many key industries involve the knowledge theory of mechanical engineering, and strong mechanical engineering education can bring significant economic and strategic benefits to the national development. China should learn from the strengths of mechanical engineering education in other countries, give full play to its strong point, and set up a complete mechanical engineering education system according to the national conditions.

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