

# Exploration and Practice of Laser Creative Product Design Course

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**Abstract**—To enhance students' innovative practical abilities, this study aims to develop small-scale innovative products using the simplest and most effective method: laser processing.

Leveraging the engineering maker space and a maker teaching team, a course on creative product laser processing is established. This course primarily focuses on the development of small products. Instructors primarily deliver lectures on design principles and equipment operation, while students propose product design concepts and, under the guidance of instructors, complete component designs and personally operate equipment for machining and assembly.

The objective of this course is to allow students to experience the entire life cycle process from design to production of simple products, deepen their understanding of large-scale engineering concepts, enhance their engineering practical skills and innovation awareness, and lay a practical foundation for addressing complex engineering problems. Simultaneously, to strengthen the integration of education, industry, and research in the curriculum, collaborative efforts with enterprises are undertaken.

The talent cultivation goals of the course are as follows: understanding of laser processing principles, mastery of laser engraving machine tool usage, proficiency in laser processing part design; completing product design; completing product processing and assembly. Through labor-intensive processes, students invest effort to gain rewards, ultimately completing an innovative work, thereby achieving comprehensive development in morality, intelligence, physical fitness, and aesthetics.

**Keywords**—Maker practice education, Laser Creative Product Design, Maker Space, Practice Teaching

## I. INTRODUCTION

With the continuous development of science and technology, laser technology has been widely used in various fields. As a high-precision and efficient processing method, laser cutting has become an important means of modern manufacturing industry. With the advent of industry 4.0, intelligent manufacturing has become the inevitable trend of manufacturing development[1]. As an important part of intelligent manufacturing, laser cutting applications continue to expand, such as automotive manufacturing[2], aerospace[3], medical devices[4], electronic products[5] and so on. Therefore, mastering laser cutting technology is of great significance for students' future employment and development.

Secondly, laser cutting technology has high innovation and artistry. Laser cutting can achieve precise cutting of complex patterns, and corresponding drawing software also provides designers with more creative space[6]. In addition, laser cutting can also be combined with other materials and technologies to create unique works of art and practical products. Therefore, the practice course of laser processing works is helpful to cultivate students' innovative thinking and aesthetic ability.

Many high-efficiency universities in China have been actively exploring the opening of laser processing courses, such as the project-based teaching of laser processing technology proposed by Jiangsu ocean university, which allows students from different majors to form teams and use interdisciplinary knowledge and methods to jointly complete the projects designated by the teacher[7]; Guiyang University adopts the teaching mode of "flipped classroom" and "fixed class hour sand open laboratory" in the teaching of laser processing[8]; Anhui University of technology divides the laser processing course into six modules for modular teaching[9]. The engineering training center of Beihang University has put forward the teaching system of "theoretical knowledge - innovative design - school enterprise cooperation - promoting learning through competition" in the teaching of laser processing, and set up the course of design and practice of creative products in laser processing.

This course is highly practical. Through the actual operation of laser cutting equipment, students can better understand the principle and technical characteristics of laser cutting, and improve their hands-on ability and practical ability. At the same time, practical courses can also cultivate students' teamwork spirit and problem-solving ability.

Courses can provide students with rich practical opportunities. By cooperating with Zhengtian laser, students can participate in actual projects, understand market demand and improve their professional skills. In addition, we also held various laser cutting creative design competitions in the school to stimulate students' interest in learning and innovative spirit.

## II. COURSE SYSTEM OF LASER PROCESSING WORKS

### A. Basic course system

Based on the teaching equipment and teaching team, this course designs a multi theme and multi-level practical curriculum system with the stages of "theoretical knowledge", "innovative design", "school enterprise cooperation" and "promoting learning through competition". The basic curriculum system is mainly composed of theoretical knowledge and innovative design. This course is mainly based on the development of small products, and mainly involves mechanism and structure design, laser processing practice and other links. The course content (Table 1) includes: understanding of engineering innovation, mechanical principle and mechanical design basis, motor drive and single chip microcomputer basis, laser processing principle and practice, product scheme discussion, product production and course defense.

Tab1. Course content arrangement

Teaching content	Basic requirements	Hours	Methods
Engineering concept	Understand the cultivation methods of laser maker and innovative thinking	2	Classroom teaching
Fundamentals	Principles and applications of commonly used mechanisms	4	Classroom teaching
Laser processing	basic concepts, characteristics, and application fields of laser processing;	6	Classroom teaching and operation
Innovative thinking training	Explaining the cultivation of innovative thinking	2	Classroom teaching and discussion
Product production	Complete product design	16	Operation
Course defense	Fulfill product requirements and complete product display	2	Presentati-on

The teacher mainly teaches the design principle and equipment operation, and the students put forward the product design concept and complete the part design under the guidance of the teacher and operate the equipment processing and assembly in person. The training objectives of the course are: to understand the principle of laser processing, master the use of laser engraving machine tools, and master the design of laser processed parts; Complete product design; Complete product processing and assembly. Based on the training objectives of the course, after the systematic teaching of this course, the students' ability to master laser technology generally achieved the expected effect and designed many creative laser processing works (Figure 1).

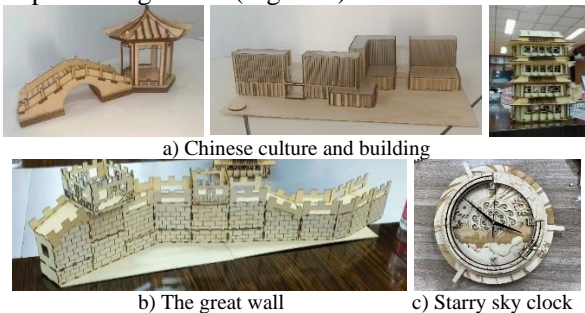


Fig1. Display of laser processing works

### B. Curriculum develop system: school enterprise cooperation and common development

Laser technology has been widely used in various fields. Mastering laser cutting technology is of great significance for students' future employment and development. In order to strengthen the integration of education, industry and research in the course, this course provides students with rich practical opportunities. Through the cooperation with Zhengtian laser (Figure 2), industry tutors are hired to provide product design guidance and establish facilities including courses, databases and spaces. Students can participate in actual projects, understand market demand and improve their professional skills.



Fig2. a) Students study in Zhengtian laser maker space

b) The course completion photo in Zhengtian laser maker space

The collaborative course model between schools and enterprises represents a significant innovative attempt in course delivery, primarily in three aspects: firstly, the course is conducted within the enterprise, utilizing the enterprise's laser cutting machines throughout. The course is co-taught by enterprise instructors and school teachers, with school teachers focusing on design theory and innovative thinking, while enterprise instructors concentrate on equipment operation and product design.

Secondly, the course projects are oriented towards innovative product design and creation. During the final course defense, enterprise mentors provide suggestions and package outstanding products for promotion. For example, the Starry sky clock has become a successful product of school-enterprise collaboration, receiving enterprise recognition and currently being promoted. The Beijing No. 1 airplane and BUAA rocket model has become the representative products of the course (Figure 3).

Finally, the school-enterprise collaboration produced an educational video about the course, which was published on national-level websites as a social service output of the course. This initiative received excellent publicity.



Fig3. Representative products of the course

### C. Curriculum develop system: combining competition with class and promoting learning through competition

Establish a resource management platform for science and innovation competition, organically combine the course content with competition training, and constantly enrich teaching cases. Effectively guide students in competition teaching and training; Organize competition sharing meetings, invite professional teachers or classmates to teach

competition experience, and encourage everyone to be brave in innovation and help each other. In daily teaching, students' innovative thinking is constantly stimulated through the introduction of competition projects, hoping to achieve the landing and transformation of technology. The concept of promoting learning through competition has achieved good results in this course. Among the creative laser processing works independently designed by students, five works have won provincial and above awards.

### III. ACHIEVEMENTS AND EVALUATION OF THE LASER PROCESSING COURSE

After the training of the laser processing course and the training of practical activities, the students have mastered the laser cutting technology and successfully designed many creative works, many of which won the honors of the competition.

#### A. Exhibition of laser cutting works: the Great Wall

The wall and beacon tower of the Great Wall have upper and lower parts respectively. The lower part is composed of small blocks, which can stack different heights of the wall. The upper part of the wall is engraved with grooves of the wall by laser, and the beacon tower is designed with a part of carving, which is connected with the wall. The whole product consists of four parts(Figure 4): city wall - beacon tower - city wall - beacon tower. There are some decorations such as bushes around the city wall. When the materials are sufficient, the assembly can continue, which also reflects the most remarkable feature of the Great Wall - long.

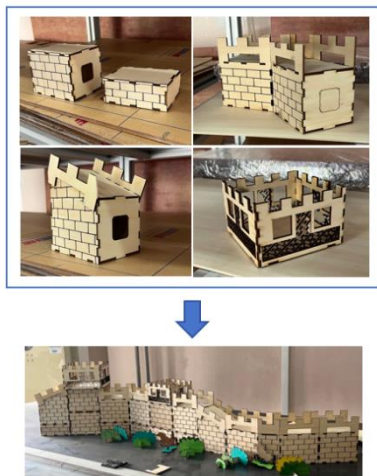


Fig 4.The wall and beacon tower of the Great Wall

#### B. Exhibition of laser cutting works: Tengwang Pavilion

On the roof of each floor, the wooden board is used as the reference plane, and a number of wood chips are placed on it. Each wood chip in the shape of a right triangle is perpendicular to the plane, but its beveled edge has a certain radian, which brings the visual guidance of the overall building upturned. This not only ensures the stability of the building, but also restores the beauty of the building to a certain extent and retains the magnificent momentum of Tengwang Pavilion(Figure 5).



Fig 5.Tengwang Pavilion

#### C. Evaluation of the laser processing course

The results designed by students and the results achieved in the competition can reflect the teaching effect of this course. Since the opening of the course, students have designed many excellent works under the cultivation of the course system, and have achieved excellent results in many competitions(Table 2).

Tab 2.Achievements of the laser processing course

Competition	Level	Prize level	Times
National mechanism innovation competition	National	First prize	2
		Second prize	3
Engineering practice and innovation competition	National	Gold award	3
		Silver award	1

### IV. FUTURE DEVELOPMENT PLAN

#### A. Expand the scale of the course

On the premise of not affecting the teaching effect and teaching order, make full use of the course resources, let more students join the course, learn and master the laser technology, and lay a good foundation for students' personal development and future employment.

#### B. Strengthen school enterprise cooperation

Continue to carry out a series of activities for students to enter enterprises, provide students with more practical opportunities with the help of enterprise resources, improve their ability in continuous practice and exercise their innovative thinking.

#### C. Enrich the course content

Timely grasp the cutting-edge scientific and technological content related to the course and share it with students, so that students' eyes are based on the times and their steps follow the cutting edge.

### V. CONCLUSION

The creative design practice course of laser cutting successfully integrates art and technology. Through the combination of theoretical learning and practical operation, students not only master the core principles and methods of laser cutting, but also improve their innovative design and

practical ability by completing innovative projects. In the course, students participate in the whole production process from conception, design to final product, deepen the understanding of large-scale engineering concepts, and enhance engineering practice skills and innovation awareness. During the process, morality is trained through the product concept, intelligence is trained through the design, physical fitness is trained through the development, and aesthetics is trained through finally optimization. The curriculum system of "theory learning - innovative design - school enterprise cooperation - promoting learning through competition" is an active exploration and practice in the field of laser processing course, and has played a good teaching effect.

The course provides students with a platform to personally complete their works and participate in competitions, and the evaluation of the course has always been in the top 10% of the college.

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