Ideas by a local college for building the course major, Materials Formation and Control Engineering

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ABSTRACT: The course major of Materials Formation and Control Engineering (MFCE) in universities and colleges is essential to provide human resources for modern industry. But there is a great gap between the educational quality of the major and the engineering talents demanded by the labour market in China. In order to improve this unfavourable situation, it is proposed to enhance students' employability by cultivating students' digital design and manufacturing and engineering capabilities, especially in the areas of metal forming and plastic moulding. Proposed in this article is the establishment of a balanced curriculum, an increase of the liberal study curricula and professional basic courses that focus on engineering and skills training. These efforts have been proved to promote students' abilities in engineering practice to improve students' adaptation to work and society, and to encourage students' spirit of teamwork and professional ethics. Many students voted *yes* to these changes in the teaching of the major MFCE, and 78% of them have found favourable career opportunities in engineering and industry.

INTRODUCTION

The course major of Material Forming and Control Engineering (MFCE) was set by the Ministry of Education of the People's Republic of China in 1998 [1], and its main educational contents include:

1. thermal processing, which changes the microstructure of the material, and the macro performance and shape of a surface;
2. moulding processes, moulding equipment, moulding process optimisation theory and methods, mould design theory and method;
3. mould materials and their heat treatment and other processing methods [2].

The major, MFCE, was integrated with several majors, such as casting, forging, welding, heat treatment and moulding. In contrast with the situation before integration, the major has a greatly broadened coverage of important roles in various sectors of the industry. Therefore, a large number of colleges have established the major, MFCE. The proposed major, MFCE, dilutes the classification of content by category of industry in contrast with pre-integration. But these colleges greatly differed in school conditions, history, the background to the major and development orientation.

So, colleges implemented the MFCE major unevenly, with some institutions sticking to the old teaching system from before integration, as with old wine in a new bottle and, therefore, cannot meet the needs of the market. Some local education institutions just mixed the old majors of casting, forging, welding and heat treatment. Meanwhile, the mechanical approach to professional education and teaching by indoctrination produces students with poor abilities in engineering practice and innovation. The MFCE major has many other problems preventing its adaptation to technological development and the needs of the economy.

Local colleges have developed quickly in recent years. But these developments have many problems, which mainly include:

1. With the passage of the old reliance on the normal, literature and history students, engineering education has not been given enough emphasis.
2. Lack of employment competitiveness of graduates: graduation could lead to unemployment, or just produces a *postgraduate training base*.
3. An emphasis on teaching, ignoring scientific research and social service functions.

The cause is misalignment and unclear thinking about the college's development. The functions of the local colleges and universities are teaching, scientific research and social services [3-4]. Local institutions largely rely on local

financial support and local human resources and, in turn, should take the initiative to service local economic development [5-8]. The development of local colleges and universities should enhance teaching, research and services for local economic and social development. Local colleges and universities should not pursue ambitiously sophisticated technology, and should not be reduced to vocational educational institutions with the loss of the status and level of a higher educational institution [5-6][9-10].

Their development should be based on the advantages of the cultivation of high-grade talent and integration with local economic growth, while maintaining the independence of the universities, strengthening research and enhancing the sustainability of the advancement of the schools. China's economy is in a period of rapid development [5]. The progress of the local economy mainly depends on industrialisation, information technology and urbanisation. Local colleges and universities' performance should be viewed from the perspective of training expertise for local industrial development [5-6].

Heze University, as a typical local institution, is faced with the important task of serving the local economy, but there are many limits of human resources and technology. It is important to develop the college and serve the local economy in the situation of limited talent and finance. The focus on both the long-term contribution to national development and to scientific research, as well as easing the short-term talent gap for the local economy form the ideas put forward by the author of this article, based on the successful building by Heze University of the MFCE major.

SORTING OUT THE WHOLE IDEA OF THE MAJOR CONSTRUCTION

To improve students' employability, students are trained in digital design and manufacturing, and engineering practice. The emphasis is on mould design and manufacturing, forming processes, forming equipment and quality control for the metal forming and plastic moulding industry. Research areas chosen are net shape and near net shape technology. The course major structure is shown in Figure 1.

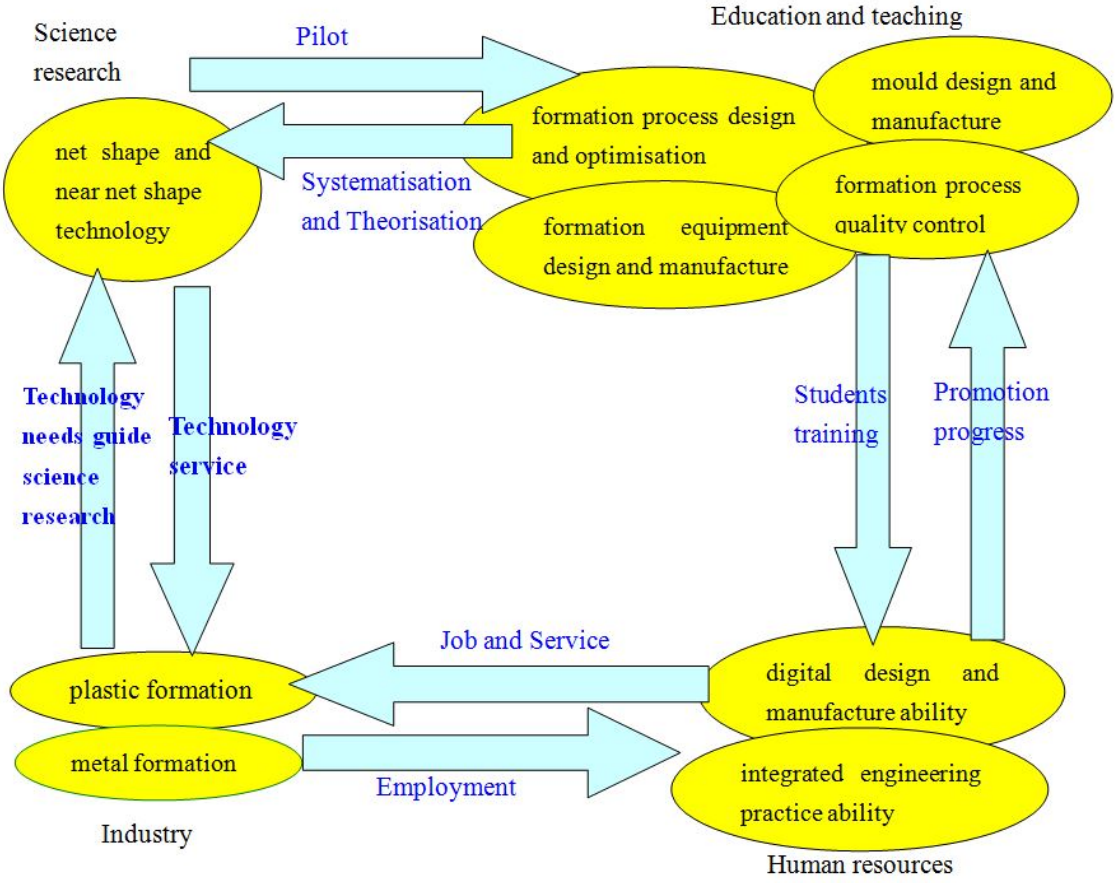

Figure1: The general structure of the MFCE major.

THE MAIN DIRECTION FOR BUILDING THE COURSE MAJOR

The main purpose of materials forming technology in the machinery industry is to develop specific geometric shape and sizes of components, while ensuring the integrity of macro-mechanical and other properties, thus, enabling the correct mechanical functionality of a product. The technical principles of materials formation rely on a material's solid mechanical and rheological properties. The core topic covers making a product's shape and size as accurately as possible; that is, to improve the precision of the material form. In recent years, with advances in materials science, various net shape and near net shape technology has developed rapidly, and has broad prospective application.

The author's research work focuses on net shape and near net shape technologies. The aim of this research is to promote technological progress and allow a foothold to be gained in the market-oriented local economy. From the various net shape or near net shape technologies, metal forming and plastic forming were selected as the specific research directions. The key teaching directions are mould design and manufacture; the forming process and quality control of the forming process.

BUILDING A RIGOROUS AND REASONABLE TUTORIAL SYSTEM

There are numerous aspects to the development of university students, including teaching, experimentation, extracurricular academic research and social services [9-12]. These play an important role in the cultivation of a student's personality, knowledge and professional skills. The main task for a student is still learning and so teaching has a central position and must be emphasised [13-17]. How to organise teaching, arrange tutorials and guide a student's learning is central to developing a course major. In fact, when adopting an economic perspective, the university is also a seller of teaching special products [3-4], or to be exact, the curricula.

In essence, the university systematically and strictly passes on subject knowledge to students, thereby, enabling them to build a scheme of systematic knowledge. So, at the centre of building a course major is the construction of the tutorial system, which includes the choice of courses and the organisation of class hours, e.g. back-to-back. Other factors, such as course preparation, course teaching and teaching methods and means, are the work of individual teachers and, hence, are the responsibility of specific teachers.

The purpose of the tutorial system is to guide students in acquiring a systematic body of knowledge. The goals in developing the course are to fit into the educational system, to have good, logical continuity and a reasonable schedule. The following are measures designed to achieve these goals.

Measure 1: To increase general education courses as a proportion of the total. Major curricula are generally divided into two parts, i.e. general education courses and major knowledge courses. The general education courses typically include English, sport, China history, law, politics, etc, and help to develop the students' humanistic qualities, and guide students in forming an independent personality.

General curricula have an important role in enabling students to adapt to modern society, and improve mental, interpersonal and teamworking skills [11-13]. Engineering in local universities focuses on training applicable to business. Students are required to develop mental endurance and teamwork, as well as to become familiar with industrial operations. The local university's engineering teaching major discussed in this article leads to an increase in the proportion of general education courses, closer collaboration with the students' union, and helps guide a student to form an independent personality and enhance their humanistic qualities.

Measure 2: The organisation of professional knowledge courses. According to specific circumstances, the professional course must be correct and rationally organised in accordance with the curriculum. The professional knowledge structure of the MFCE major is shown in Figure 2. From this follows the development plan, technology, equipment and tooling for the main research, and the supporting disciplines, including materials and machinery, as well as control, mechanical and electrical subjects. Based on these considerations, the course structure of the MFCE major is shown in Figure 3.

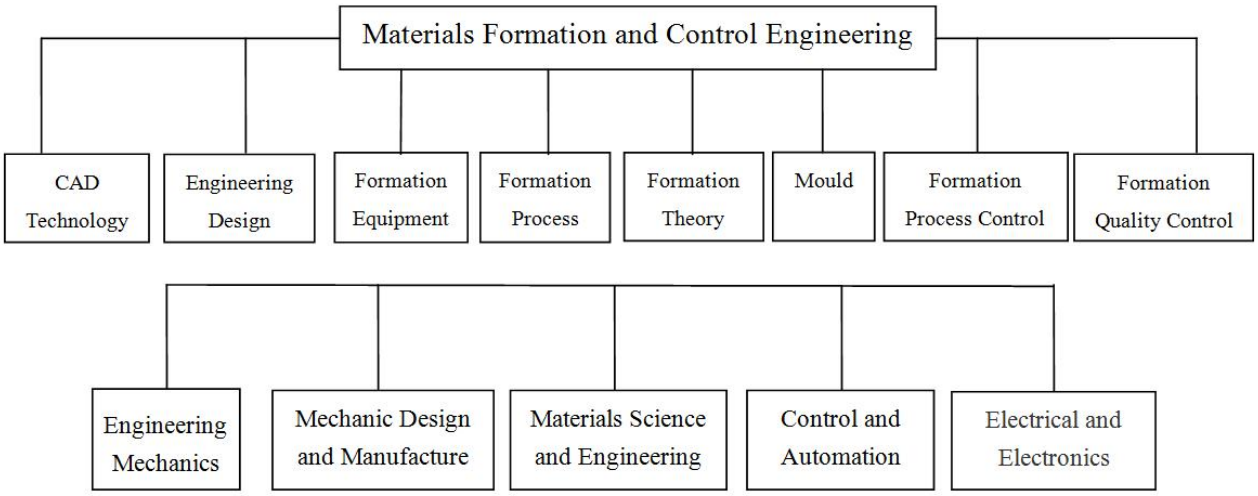

Figure 2: The knowledge structure of the MFCE major.

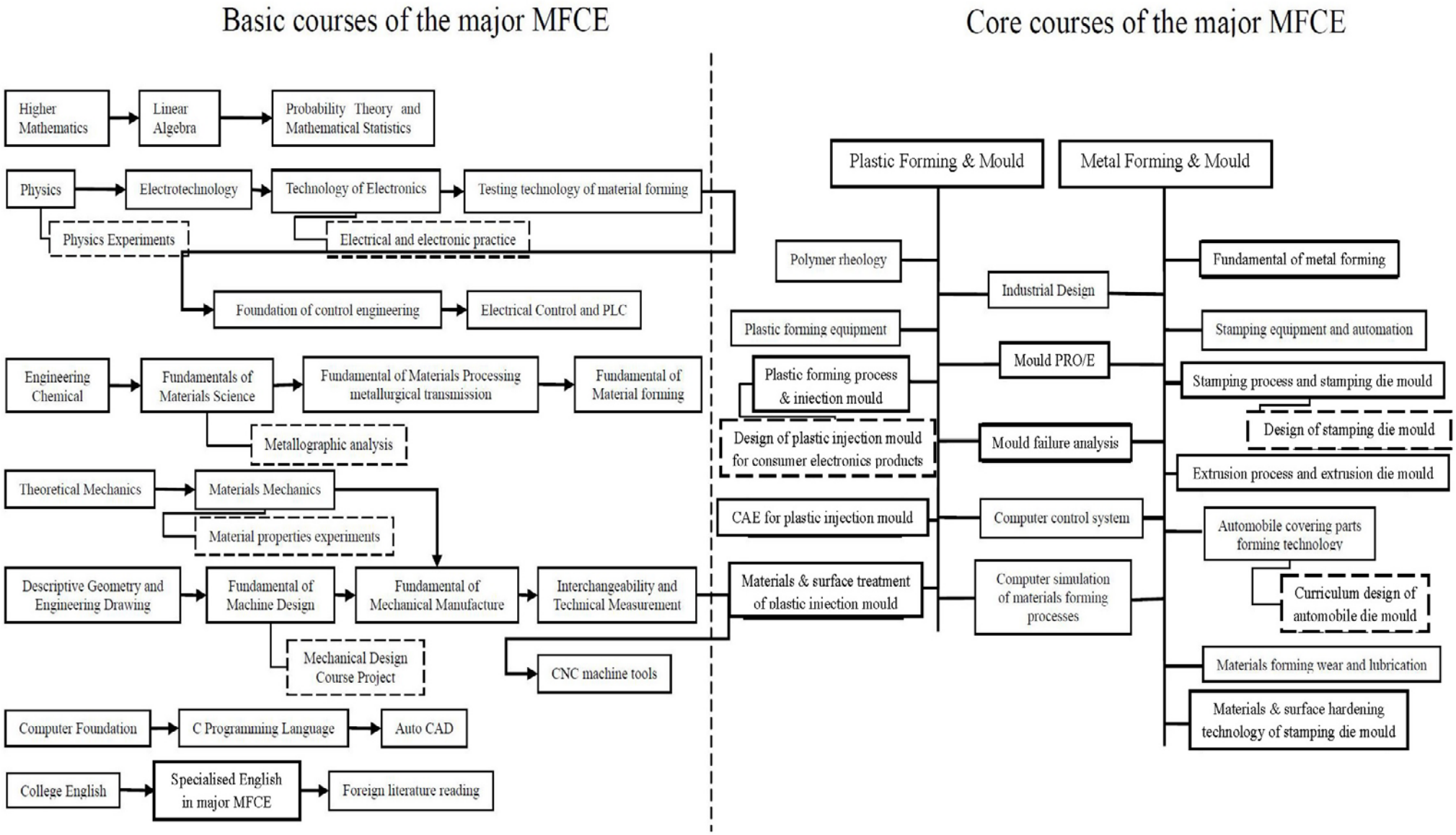

Figure 3: Course structure of the teaching system of the MFCE major.

Measure 3: To strengthen the basic course teaching of the major MFCE. The basic and core courses of the major enable students to adapt quickly to technological advances. There is an emphasis on materials, machinery, control and other important foundation subjects, with an increase in the number of courses and course hours. There is a focus on strengthening the teaching of electrical and control courses. Electrical and control technology has developed rapidly in recent years. This has greatly changed the traditional outlook of the industry, promoted rapid industrial development and played an important role in the national development strategy of *information technology to stimulate industrialisation* and *industrialisation to promote information technology* [5-7]. The author believes that the material formation industry, as well as electrical and control technology also play a great role, and the teaching of electrical and control courses should be strengthened.

Measure 4: To focus on the curriculum for mould design and manufacturing and forming processes in teaching. Plastic moulding and mould, metal forming and die were selected as two key professional directions. Also selected were the relevant professional orientation courses, with an emphasis on their usefulness and with frequent updates of the course content. The professional orientation course has five aspects, including the forming process, forming principles, forming equipment, forming process quality control and mould. The teaching focus here is on three of these, i.e. the mould design and manufacture, forming process and forming process quality control.

PROGRESSING PRACTICE-ORIENTED AND STRENGTHENING SKILLS

The MFCE major involves significant technology and requires the students to develop a comprehensive ability to solve practical problems using engineering practices. This higher skills and professional development matches the higher skills required for major constructions and buildings.

In contrast to course experiments, the integrated practice design course requires students to comprehensively use theoretical knowledge to make an actual engineering design. This is important in promoting students' sense of innovation and ability to apply themselves. Examples were provided to cultivate the students' abilities. These examples included stamping dies, injection moulding of consumer electronics products and metal forming mould, and others [16-18].

Factory internship training was strengthened. Factory front-line jobs cultivate a student's awareness of modern industry including the practical aspects and the need to adapt. Students' employability and competitiveness are improved by co-operation with schools, student internships, research and summer off-campus engineering activities [9-11].

IMPROVING SCIENTIFIC RESEARCH TO PROMOTE THE QUALITY OF TEACHING

Scientific research informs teaching. A high level of scientific research supports teaching with new theories and new knowledge [2][15]. Scientific research has been vigorously strengthened by selecting a *hot* topic from the materials formation industry, e.g. net shape and near net shape technology, and undertaking joint research with related enterprises, which help to successfully overcome technological problems. This promotes improvement in the quality of teaching.

CONCLUSIONS

The teaching content and curriculum of the course major, Materials Formation and Control Engineering, was reformed three years ago. The new teaching programme was executed in 2011 and 2012. These students opined: *We vote yes to the major. The teaching programme is good and promotes teaching quality.*

The MFCE major was developed with an eye on the needs of the local economy and enterprises, and close links to local industry. Three years of teaching practice has proved the major a success with its wide adaptability of student work and the course has been welcomed by enterprises. The MFCE major provides better employment outcomes than other majors. Thirty two graduates, accounting for 78% of the total, found good jobs in the summer of 2012.

Talented engineering graduates should have professional knowledge, skills and ethics competencies. The cultivation of these abilities and qualities will be developed not only through university education. Universities and colleges cannot train all students to a qualified level in product manufacture and materials processing, but students can be made aware of how to become a qualified engineer in product manufacturing and materials processing.

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