

## **Optimization of the Cultivation Mode for Full-time Professional Master of Engineering Disciplines in China**

Yan Li Ph.D. Associate Professor (Corresponding Author)

School of highway, Chang'an University

Middle Section of the 2nd Ring Road(South bound), Xi'an, Shaanxi, 710064, China

Email: [lyan@chd.edu.cn](mailto:lyan@chd.edu.cn), Phone: (+86)-29-82334636

Huiting Cheng Graduate assistants

School of highway, Chang'an University

Middle Section of the 2nd Ring Road(South bound), Xi'an, Shaanxi, 710064, China

Hong Chen Ph.D. Professor

School of highway, Chang'an University

Middle Section of the 2nd Ring Road(South bound), Xi'an, Shaanxi, 710064, China

Chaoqun Ma Ph.D. Associate Professor

School of highway, Chang'an University

Middle Section of the 2nd Ring Road(South bound), Xi'an, Shaanxi, 710064, China

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**Abstract:**

*The cultivation mode of the full-time professional master of engineering disciplines is optimized. The cultivation objectives of professional master are refined as a comprehensive abilities cultivation matrix with five-levels cultivation objectives and seven-levels cultivation abilities. The correlation analysis between the cultivation process and comprehensive abilities cultivation matrix indicate that the school duration can be extended to 2.5-3 years. The cultivation objective of each semester is also optimized associated with the schooling system. For the purpose of improving the practical abilities, some specialized courses can be adjusted as a so called practical course in the form of comprehensive curriculum design. A five-level evaluation system is also established to achieve the requirements of evaluating the abilities of the professional master a different phase. The explorations on the cultivation mode of professional master can be references to training institutions of professional masters.*

**Keywords:** Full-time professional master, Cultivation mode, School duration, Course system, Evaluation system

**1. Introduction**

A master's degree is a second-cycle academic degree awarded by universities upon completion of a course of study demonstrating mastery or a high-order overview of a specific field of study or area of professional practice (Blouin et al., 2011). The professional master degree in many disciplines is relatively new in China, which was firstly set in 1990 (Wang & Zhu, 2009). However, there were only professional master for architecture and part-time master in engineering disciplines at that time. The ministry of education of China decided to set full-time professional master in most engineering disciplines to meet the great demands for high quality engineers at 2009. Meantime, the academic masters number would be reduced (Zhang & Pan, 2011).

The cultivation process of higher education varies in different countries. However, higher education in most countries follow the form of Bachelor/ Master/Doctorate (Lozano, Lukman, Lozano, Huisingh, & Lambrechts, 2013). For example, there was not a Bachelor degree in Germany. Some students struggle for graduation, and have a poor employment prospects. Then, the Germany governments are abolishing the traditional "Diplom" (Master of Science) and "Magister" (Master of Arts) gradually, even the "staatsexamen". Then, the cultivation system of "Bachelor/ Master" is adopted (Phillips, 2015). The France also apply a new schooling system, "Licence-Master-Doctorat" schooling system (Klapper, 2013), to replace the traditional one.

The schooling system of master degrees in five counties are summarized in table 1. The master degrees usually fall into two categories: academic master (or research master) and professional master. The academic master has the qualification to continue pursuing a doctoral degree, which should focus on the cultivation on abilities of scientific research. The academic master can be divided into Master of Sciences (M.Sc.) and Master of Arts (M.A.) (O'Byrne, Dripps, & Nicholas, 2015) based on the related subjects. The school duration is usually 2~3 years. The cultivation modes include course teaching, course practice and dissertation. The cultivation on professional master mainly focus on the abilities of development and design in field applications. There are no specific requirements on the abilities of scientific research for professional master. The professional master can be named depends on its disciplines, such as Master of Engineering (M. Eng.) and Master of Business Administration

(MBA)(Lisitzina et al., 2015). The school duration for professional master is usually 1~2 years with the evaluation forms of case teaching, research-discussion, field practice, curriculum design, dissertation and even in the form of course design, report and examinations(Geng, Jiang, & Shan, 2015). Compared with academic masters, the professional master emphasis on the practical ability.

**Table 1 The categories and school duration for master degree is selected countries**

Country	Categories of Master's Degree	School duration
US	Research Master's Degree	2-3 years
	Professional Master's Degree	1-2 years
	First Professional Degree	6-8 years
UK	Postgraduate research	One year or more
	Postgraduate taught	One year or more
	Postgraduate Certificate of Education (PGCE)	One year or more
France	Diplôme d'études Approfondies (Diploma for Further Studies, Traditional)	2 years
	Master Recherche (Master of Research, Current)	2 years
	Diplôme d'études supérieur spécialisées, (Diploma in Higher Education Specialist, Traditional)	2 years
	Master professionnel (Professional master, Current)	2 years
Japan	Diplôme d'ingénieur (diploma of Engineer)	2 years
	修士(Research Master)	2 years
Korea	專門職学位(Professional master)	2 years
	연구석사 (Master of Philosophy)	2-3 years
	수업석사 (Master of taught course)	2years

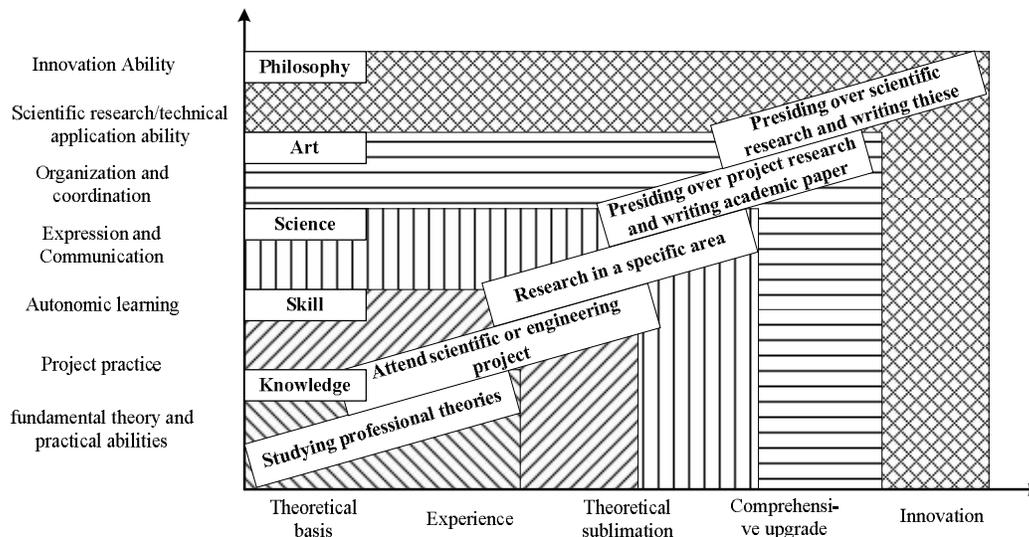
Although the cultivation mode of professional master is explored for years, there are still many questions on cultivation objectives, course system, training process and evaluation systems. In this way, the aspects listed above should be further discussed to improve the cultivation qualities of the professional master in engineering disciplines. The explorations on the cultivation on professional master of engineering disciplines are introduced in this paper.

## 2 Cultivation Objectives and Strategies

### 2.1 Cultivation objectives

The master education is an initial stage of graduated education. In this way, the cultivation objective of the master education should focus on the development of independent thinking ability of high-level technologies in

specific field. The professional master should be professional experts with following abilities: ① knowing the fundamental knowledge and technologies of a professional area;② with the abilities to solve practical problems; ③ being well trained in vocational ethic, good mentality and high work efficiency. Although there are differences in the cultivation objectives of the academic master and professional master, both of them have equally meaning to the development of the society in different ways(Zhu, Li, & Chen). And the graduation requirements should be consistent of these two kinds of masters. As shown in Figure 1, the process of master's ability cultivation show a gradient form. The cultivation of postgraduate education starts from the fundamental theory and practical abilities. The skills of project practice, autonomic learning, expressing and communicating should be major contents that a master should learn. Advanced capabilities contain the organization and coordination capacity, scientific research/technical application ability and innovation ability. The ability of each level corresponds to the cultivation requirements level from knowledge to philosophy. In the skill cultivation process, the education of professional master should focus on high-level abilities of engineering applications and competences. The training objectives and capacity requirements constitute a comprehensive capacity- cultivation matrix for full-time professional masters.



**Fig.1 Analysis on the ability requirements for master degree**

**2.2 Guiding ideology and implementation strategies**

In accordance with the cultivation objectives and capacity requirements of professional master, the advantage capabilities should be developed based on solid professional knowledge and practices. Therefore, the cultivation of professional masters should follow a procedure from theory to practice and then back to theory, and meantime, from basic skills to innovative ideas. In the teaching process of the professional master, we should fully consider the requirements of the employer. The comprehensive accomplishment, application knowledge and ability enhancement are major abilities that the professional master should obtain, which mean the practical ability and entrepreneurial ability are prerequisite.

The optimization of professional masters' cultivation mode should solve the current problems and meet the requirement of knowledge and professional literacy in specific filed. The implementation strategies can then be developed as follows:

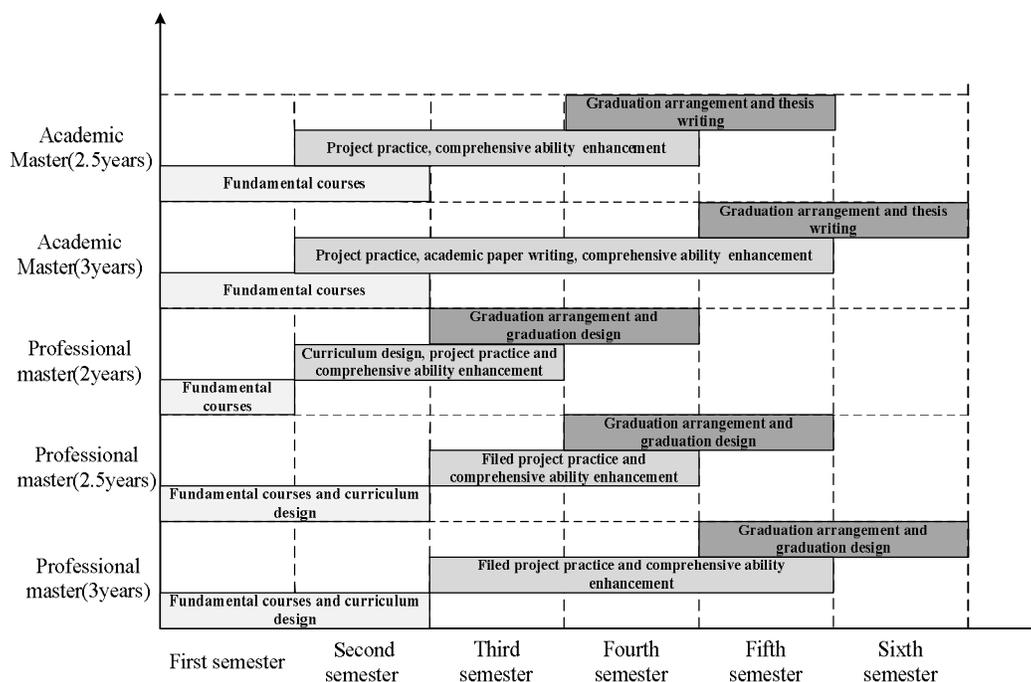
1. Optimization of the school duration. The training program of the professional master should be optimized in accordance with training requirements of different stages to ensure the acquisition of corresponding abilities.
2. Optimization of the teaching process. Following measures can be considered to apply in the teaching procedure: ① increase the proportion of practical course, ② the course can be design based on industry qualification certification knowledge system, ③ considering the utilization of case teaching, simulated training, field observation, practical operation in the course teaching process.
3. Optimization of the evaluation criteria. Change the assessment methods of the course to focus on the ability of learning basic knowledge and skills to solve practical problems.
4. Encourage enterprises to participate in teaching process. Strengthen the practical ability and entrepreneurial ability of professional master.

### **3. Optimization of Training Process**

#### **3.1 Optimization of school duration**

According to the requirements of master's training, master's training should be divided into the stages of basic knowledge learning, professional knowledge practicing, summarization and sublimation of theory, comprehensive ability upgrading and cultivation of innovation ability. The corresponded teaching process are fundamental course, curriculum design, academic paper writing, real filed project practice and graduation design. The Chinese Ministry of Education recommends that the school duration of full-time professional master to be 2 years. The practical teaching procedure should be not less than six months of all the schooling period, which can be a combination of concentrated practice and multiple phase practice. During the cultivation process, the graduated students should learn fundamental courses and complete the curriculum designs and other aspects. In the second year of schooling, the students should finish project practice, graduation thesis and other aspects. Most universities do not require academic paper for graduation.

As shown in Fig. 2, it is difficult to achieve the training requirements of professional masters in two years or less, which is 2.5~3 years for academic masters. The employers don't want to recruit the professional masters for the reasons of lacking teamwork, innovation and other advanced capabilities. It's necessary to optimize the school duration to improve the quality of education. It is recommended to extend the school duration as academic masters. In this way, the training institutions can have enough time to teach advantage abilities to professional masters.



**Fig. 2 Comparisons on school duration for full-time masters**

### 3.2 Reform of course system

At present, there are very little differences in the course system between the professional master and academic master. The major differences are school duration and credits needed for graduation. However, the course system of professional master, and their contents and evaluations are similar to academic master's. Therefore, it is suggested to reform the course system based on the cultivation objectives and implementation strategies.

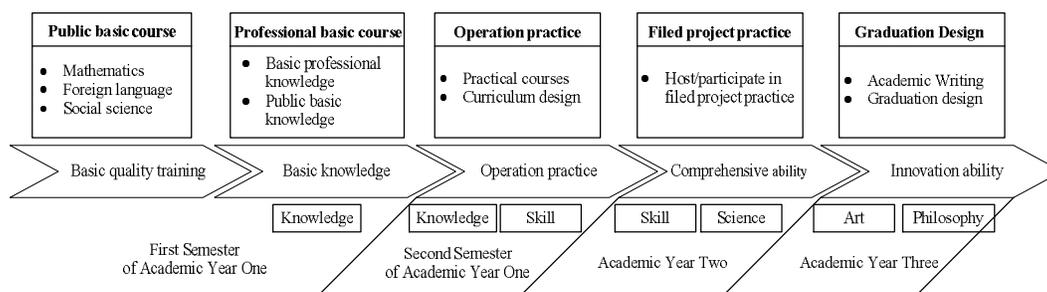
Graduate courses can be divided into three types: fundamental courses, project practical (or curriculum design) and scientific research. The course system of professional master should enlarge the percentage of project practical (or curriculum design) courses to meet the requirements of employers. Meantime, the fundamental courses should focus on teaching the basic theories that may needed in filed practices. The fundamental course irrelevant to the specialty can be amalgamated. The scientific research type course can be reduced appropriately.

The reformed courses system of professional master can then be divided into the following types: cultivation of basic quality, basic operation practice, cultivation of comprehensive ability and innovation ability.

As shown in Figure 3, the procedure of cultivation of basic quality includes public basic courses and professional basic courses. The basic operation practice mainly means curriculum design and other practices at campus. The cultivation of comprehensive ability of professional masters can be achieved by filed project practices and academic paper writing. The graduation evaluation will focus on the abilities of innovation.

The courses of professional master can be further divided into fundamental basic course and practical courses. All the courses should be finished in the first academic year. If the fundamental basic courses can be finished in the first semester, we can arrange all the practical courses in the second semester by the form of several

comprehensive curriculum designs. The filed practices are suggested to implemented in the second academic year. The summaries on the practices are expected to be a critical way to enhance the comprehensive abilities. If the training institutions feel difficulties to find place for field practice, the professional masters can complete this task by attending the research projects of their supervisors. The professional masters should finish their graduation arrangement and the thesis for the master degree.



**Fig. 3 Design of the framework on professional master's course system**

In the reformed course system, the practical course is a specific course designed for the professional masters. The practical course adopts curriculum design instead of lecturing. The practical courses will have certain subjects that related to research field. The students should complete the curriculum design according to the actual work requirements and standards within the stipulated time (One to two weeks, 20-30 class hours/week). The practical course will be finished by group. All the topics in these courses will be real projects materials to recur the real work situation. Practical ability and teamwork capability will be also gained by attending these courses. It is suggested to take 3-5 practical course for a professional master.

The course system is then optimized as shown in table 2. The course systems of masters in transportation engineering (Chang'an University, China) are also compared in table 2. It's obvious that the optimized course system greatly enhanced the practical ability of professional master.

**Table 2 Comparisons of various master course systems**

	Academic Master	Professional Master (Before)	Professional Master (After)
Public basic course	8	6	≥8
Professional basic course	6	4	≥8
Practical courses	-	-	≥8
Academic degree course	18-21	16-19	16-19
Elective course	≥9	≥9	≥9
Other aspects	5	5	5
Total credit requirements	30-32	28-30	28-30

#### 4 Optimization of Evaluation System

The scientific management and evaluation system on cultivation process is the basic guarantee to keep quality of professional master. The process of course teaching, mid-term evaluation, thesis writing and final defense should be examined and evaluated comprehensively. A five-level-evaluation system is then proposed to achieve the goal of cultivating. The five levels evaluations are: checkup after matriculation, course examination, practice evaluation, mid-term evaluation and final defense. The objectives and detail contents of each evaluation are listed in table 3.

*Table 3 Objectives and contents of five-level-evaluation system*

Evaluations	Evaluation time	Evaluation content
Checkup after matriculation	After matriculation of first semester	Basic theories or skills of the discipline that should be known by university graduates. Students who don't pass the examination will retake related courses, which are not included in graduation credits.
Course examination	At the end of each course	The graduate students should meet the requirements of all the elective courses to earn enough credits for graduation. The evaluation can either be an examination or other comprehensive evaluation given by the teacher. A make-up exam will be provided for the students failed to pass the course evaluation.
Practice evaluation	After the end of practice	There will be course practice and filed project practice. The director of the practice will be responsible for the practice evaluation. The students won't get the credits of the practice course or filed project practice unless they pass the related practice evaluations.
Mid-term evaluation	At the end of third semester	A comprehensive evaluation on all the aspects of the graduated students at the middle of the cultivation process. The students should get all the necessary credits for graduation. The graduated students who pass the evaluation can continue his/her position as a master student, or can only earn a transcript for graduation.

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Final defense	At the end of schooling	Besides the dissertation, the final defense of the professional master can also be in the form of research report, planning and design scheme, developed product, case analysis or project management report. The topic should come from the field practices Graduation design must be completed independently. The members of the final defense committee should be experts with senior professional and technical positions in relevant field.
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## 5. Safeguard Measures

The safeguard measures on the cultivation process mainly focus on the quality control system, process management and highlight the role of instructors.

Quality control is the key point of cultivation monitoring system. An instruction committee for the professional master is suggested to set up to formulate basic requirements of the degree, perfect course system and carry out quality evaluation. The cultivation process of the professional master should concern on the evaluation of high-level engineering application and professional competence.

Process management should be strengthened in cultivating monitoring system. Every step of the cultivation process should be evaluated using specific standards, such as entering education, course teaching, practice course and filed project practice, mid-term evaluation, academic paper writing and final defenses. The process management can become standardized and meticulous by refining the regulations, managing scientifically and improving the management information systems.

Cultivating monitoring system should also highlight the role of instructors. A high-quality instructor team in all the related areas will be the guarantee to excellent professional masters. The instructors should be full of responsibility to explore the ways in the course reform and cultivation process.

## 6. Conclusions

Following suggestions are suggested for the cultivation mode and course system of professional master in China and other countries:

1. The schooling length should be extended to 2.5-3 years for the professional masters with strong engineering background.
2. The practice courses are suggested to be added in the course system to carry out related practice training at campus.
3. The teaching contents are optimized by strengthening the basic principles, and engineering practical contents.
4. The management and evaluation system can ensure the improvement of the fundamental ability and innovation ability of the professional master.
5. Further optimizations on the cultivations of the professional master can be discussed based on the cultivation objectives and new problems in the cultivation process.

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