AC 2011-980: COMPARATIVE STUDY OF FIRST-YEAR ENGINEERING HONORS PROGRAMS BETWEEN US AND CHINA

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Comparative Study of First-year Engineering Honors Programs between US and China

Abstract

In the era of the 21st Century, the call for change in engineering education has been highlighted and documented. To respond to the challenge of global engineering technological and environmental alteration, some renowned engineering-oriented universities in the United States offer highly motivated, academically excellent undergraduate engineering students with a broader, more enriched academic experience during their years of college. Meanwhile, on the strength of the advantage of rapid economic growth and absolute number of engineering graduates, on the other side of the world, top engineering-centered universities and institutions in China launch programs to cultivate talented undergraduate engineering students to help promote its pace to industrialization. Previous research studies both in the United States and China have generalized and summarized their experiences and characteristics to design and implement their unique engineering programs; however, there are few comparative studies between the two countries on this topic.

Therefore, this paper presents a comparison between a First-year Engineering Honors Program at a university in the United States and a first-year of Undergraduate Honors Program implemented by a university in China. The paper will mainly compare the following three aspects: the program overview, central program themes, and the curriculum system through interviews with directors of both programs.

The results of this paper will present the directors’ outlooks of the ongoing programs in both a theoretical level (program vision and mission), and in an operating level (curriculum). The reasons for the programs’ similarities and differences will be thoroughly discussed based on a broader and comprehensive international and educational background, in order to obtain a more clear understanding and more rapid advancement of this kind of programs.

Introduction

First-year Engineering Honors Programs (FEHPs) provide highly motivated, academically excellent first-year engineering students with a broader, and more enriched academic experience. In the United States, FEHPs have evolved at colleges and universities over several decades. Research on FEHPs in the United States almost covers every aspect of ongoing programs, such as teaching aims, curriculum system, administrative structure, program evaluation etc. Other research concentrates on one or more specific characteristics, such as involving humanities awareness or introducing research into an engineering honors program, highlighting leadership
experience and engineering projects, or compares engineering honors students with non-honors students in terms of GPA and other academic performances.

In another part of the world, China is promoting its rapid and sustained economic growth presently. Stimulated by the growing economy and developing industrial market, China’s engineering education has become the world’s largest in scale. Engineering undergraduate enrollment has reached 6.72 million in 2009, contributing 35.6% to the whole enrollment number. Within this context, engineering honors programs have been launched in succession by Chinese top engineering-oriented universities and institutions with the support from China’s Ministry of Education and China Academy of Engineering, in order to educate undergraduate engineering honors students. Examples of the ongoing programs are listed in Table 1:

Table 1: Examples of Engineering Honors Programs in China’s Universities

<table>
<thead>
<tr>
<th>Universities</th>
<th>Project Titles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tsinghua University</td>
<td>Hsuch-Sen Tsien Mechanics Program, Andrew Chi-Chih Yao Software Engineering Program</td>
</tr>
<tr>
<td>Tianjin University</td>
<td>Engineering High-level Program</td>
</tr>
<tr>
<td>Shanghai Jiaotong University</td>
<td>Elite Engineering Education Program</td>
</tr>
<tr>
<td>Tongji University</td>
<td>Innovative Competence System for Engineering Students</td>
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<tr>
<td>Huazhong University of Science &amp; Technology</td>
<td>Experimental Zone for Engineering Education Reform</td>
</tr>
<tr>
<td>Zhejiang University</td>
<td>Chu KoChen Honor College</td>
</tr>
<tr>
<td>East China University of Science &amp; Technology</td>
<td>Total Engineering Education Program</td>
</tr>
</tbody>
</table>

The earliest recorded first-year engineering honors program in China was initiated by Zhejiang University in 1984. It was called “Hybrid Class” since it mixed freshmen from different engineering departments. In 1998, a constructive project called the “985 Project” was conducted by the Chinese government, aiming to found world-class universities in the 21st century. In light of the “985 Project”, engineering honors programs were increasingly established at that time in China’s engineering-oriented universities. Each program started with a first-year session called FEHP, but the time length ranges from one year to four years or even longer. In June 2010, an “Outstanding Engineers Educational Project” (OEEP) organized by China’s Ministry of Education extended the boundary of engineering honors programs to a nationwide scope. 61 universities were selected as members in the first round pilot. Under the framework of the OEEP, the “general standards” and “university working agenda” of engineering honors programs have been broadly discussed.

Previous research studies have generalized and summarized the experiences and characteristics to design and implement the FEHPs, however, there are few studies concerning international comparison on this topic. Thus, this study will compare two ongoing FEHPs in the United States...
and China, which is expected to contribute to the current body of knowledge about FEHPs and honors students—both theoretically and practically.

**Research Targets and Methods**

**Research Targets**

The research targets, two FEHPs in the United States and China, are selected from a large number of nationwide similar programs based on the consideration of the factor of time, typicality, as well as the author’s background and research experience. For convenience in narration, we name these two programs FEHP-US (FEHP in the United States) and FEHP-CN (FEHP in China) for short. Correspondingly, we also name the target universities Uni-US (University that implements FEHP-US) and Uni-CN (University that implements FEHP-CN) for abbreviation.

**Methods**

This research is primarily conducted by interviewing both programs’ directors, in the United States and China. Based on the research targets, a list of open-ended questions were initially brainstormed and developed by the author, and then generalized into eight interview questions. Each question was written in English and Chinese simultaneously to adjust to international situations. Two copies of the complete list of questions were sent to two selected experts in the target universities. One of the experts works as an Engineering Education faculty member who takes charge of a similar first-year engineering course; the other was an engineering education expert and academic consultant of the engineering honors programs. Both experts examined and revised the existing questions in grammar and expression, provided feedback to make the questions more interviewee-friendly, and suggested one additional question which led to the final list of nine questions (see Appendix A).

After the research exemption request was approved by the Institutional Review Board (or equivalent) in both universities, emails were sent to both Directors of FEHP-US and FEHP-CN to request for appropriate interview opportunities. A two-session face-to-face interview was firstly conducted with the Director of FEHP-US in the working office. After each session, a summarized interview review was written by the interviewer, and then sent to the interviewee to obtain feedback. On the other hand, due to geographic restrictions, the same copy of interview questions was directly sent to the Director of FEHP-CN by email. The Director gave written answers to each question, and then replied via email to the author. After that, a telephone interview was made from the author to the Director of FEHP-CN in order to attain more detailed explanations to some specific questions. Approved by both Directors prior to the interviews, the interviews were recorded using a voice recorder for further analysis and research.
Findings and Discussions

The interview responses were analyzed and categorized into three major aspects and groups of contexts (See Table 2). Substantially the classification and comparison applies the reasoning sequence of the interview questions. In each of the following sections, discussions of similarities and differences between the two programs follow after an initial discussion of each theme.

Table 2: Aspects and Contexts for Comparison of FEHPs

<table>
<thead>
<tr>
<th>Aspects</th>
<th>Contexts</th>
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<tbody>
<tr>
<td>Program Overview</td>
<td>Historical Evolution and Program Architecture</td>
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<td>Students and Faculty</td>
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<td>Central Program Theme</td>
<td>Understandings of Honors Student and Program</td>
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<td>Vision and Mission</td>
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<td>Curriculum System</td>
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Findings of the Program Overview

a) Historical Evolution and Program Architecture

The history of FEHP-US dates from the late 1950s. Since that time the honors program has been part of the first-year program in Uni-US. In 2002, a 7 credit hour honors coursework was initiated for a group of 10% of the first-year engineering students in both fall and spring semesters. From that time, the FEHP was distinct from the university-wide honors program, and transformed to be an engineering-specific program. In 2005, the policy-makers began expanding the previous first-year engineering honors program into a four-year program: the College of Engineering Honors Program (CoEHP). An overarching framework of FEHP-US was made to describe what the honors experience was, and each engineering department created their own honors programs that meet the requirements of the framework.

Compared with FEHP-US, FEHP-CN was newly launched in September 2002, the 50th anniversary of the founding of Uni-CN. In China, numerous engineering-oriented universities were founded around early 1950s due to the policy of restructuring of universities and colleges. On the one hand, it was an appropriate time to summarize previous practices of engineering education programs as Uni-CN stood on the milestone of 5 decades; on the other hand, inspired by the “985 Project”, a number of honors programs had been launched or planned to launch by other engineering-oriented universities in China since then. Hence, Uni-CN took the advantage of the opportunity to get fundraising from its higher authority–former State Commission of
Science and Technology for National Defense Industry, and the resolution of founding a new School of Advanced Engineering (SAE) aimed at cultivation of engineering honors students was smoothly passed and finally approved by Uni-CN in 2002. After intense discussion, SAE started to implement a four-year program for the top 5% of incoming first-year engineering students, in which FEHP-CN was the program students enrolled in for their first year.

b) Students and Faculty

Right now there are approximately 200 first-year engineering honors students in FEHP-US, a little bit beyond the director’s expectation of 150, which is about 10% of the total enrollment of College of Engineering each year. Although the student number steadily grows, class sizes in FEHP-US are strictly maintained as 50-60 students per class to ensure every participant has opportunities to participate in in-class practice activities and frequent interactions with faculty. Similar stories happen in China, too. FEHP-CN presently enrolls 50 honors students each year. It is the same consideration to keep the small class size.

In terms of faculty, there are currently 3 faculty serving as instructors including the director who serves as the academic advisor for all first-year engineering honors students for FEHP-US. Each engineering school and department in the CoEHP (13 schools in total) has identified one honors mentor to connect the relationship between FEHP-US and the honors program in the upper divisions. The circumstance varies in FEHP-CN due to the differences in the administrative and curriculum systems. The whole program is administrated by 5 host faculty, and classes are taught by 12 invited faculty from China’s top universities. Each honors student in FEHP-CN is matched with an academician in the China Science Academy/China Academy of Engineering, or a full professor who has the distinction of senior graduate advisors, in order to acquire experience of long-term mentoring and guidance from the first year until graduation.

c) Entry Requirements

Both programs have set entry requirements, which primarily concern applicants’ high school academic performance. One of the FEHP-US requirements is an SAT score of 2050 or an ACT score of 32 AND top 5% class rank. The admission requirements of FEHP-CN are even more strict and complicated. Every spring, FEHP-CN hosts a series of preliminary exams in China’s different provinces, selecting FEHP-CN candidates in the name of autonomy enrollment. After the annual National Entrance Examination of Universities (NEEoU), students who pass FEHP-CN preliminary exams, associated with top rank students in NEEoU who have already enrolled in Uni-CN are gathered to take a final exam to obtain eligibility for FEHP-CN before the fall semester starts. The final exam includes a written test and two rounds of face-to-face interviews. It not only examines students’ academic ability in mathematics and physics, but also concerns students’ potential for learning new knowledge. All interviewers are faculty, senior professors, and program consultants who take responsibility for mentoring the FEHP-CN
students. In other words, the interview sessions give mentors opportunities to scout out apprentices as well as future cooperative partners.

After admission, there are more specific requirements to keep participants consistently excellent. All honors students in FEHP-US must meet the First-year Engineering Program requirements; complete a minimum of one three-credit hour honors course each semester; achieve a minimum 3.6 cumulative GPA by the end of the spring semester; and participate actively in at least one student organization. In FEHP-CN, a mid-term selection is routinely held at the beginning of the spring semester, which eliminates unqualified students and selects new students from “traditional” non-honors freshmen programs. However, as the FEHP-CN curriculum system is considerably different from any non-honors programs in a variety of schools and departments, it is extremely challenging for non-honors students to pass the mid-term selection. Only by contacting and getting approval from one faculty in FEHP-CN prior to the mid-term selection can they obtain opportunities to get involved in the spring semester.

d) Other Program Features

FEHP-US will set up a portfolio system beginning in Fall 2011 to track honors students during school and after graduation for 5 or more years. FEHP-CN is conducting a similar effort to record what awards honors students get after school. Both the program directors are interested in knowing what really motivate honors students, in order to attract more students to participate in the programs.

With regard to accommodations, FEHP-US Students are eligible to apply for the Honors Engineering Learning Community (HELC). The purpose of the HELC is to increase student learning and success by encouraging students to be a part of a community of learners. Participants share linked classes, a residential experience, and co-curricular activities in the HELC. This living style is more common in China, since it is a custom for Chinese universities to offer on-campus apartments to undergraduates, so that students in the same major or department invariably live in the same or nearby apartments. Compared with universities in the United States, it is much easier to do so, since most undergraduates in China’s universities are native Chinese, who have similar habits and living patterns. Particularly, FEHP-CN assigns a full-time advisor to help students with their campus life.

Discussions of the Program Overview

In this section we find that FEHP-US launched independently much earlier than FEHP-CN, but recently it transformed into a four-year engineering honors program in the College of Engineering Honors Program (CoEHP). Likewise, engineering honors program in School of Advanced Engineering (SAE) covers the entire four years. This reflects two meanings. On the one hand, the importance of FEHPs has been continually manifested and emphasized, as it is not
only the first stage of the entire honors program, but it also takes the responsibility of getting
honors students well motivated and prepared for future engineering study and work. The major
difference in first-year programs between Uni-US and Uni-CN (actually between most
universities in the United States and China) is that in the United States, there is at least a
one-year period in which students take “general education” courses. However, there is no similar
general education in most Chinese universities, so most freshmen study in only one school or
departments in China. Nowadays, some Chinese universities have attempted to apply first-year
programs to adopt the mode of general education in U.S. universities, nonetheless, general
education is not widely adopted in most universities in China due to lack of experience and
education resources. On the other hand, we discover that the time span of engineering honors
program has gradually extended to four years. Thus there will be two continuous phases in
engineering honors programs. The first phase is an introductory phase in lower grades to
introduce students into engineering networks and prepare them for future study, and the second
phase focuses on engineering departmental study in upper grades. Sometimes the division of
these two phases is not as precise as 1 year and 3 years. To a great extent, it relies on the duration
of general education in the target university, only if the university adopts general education. In
Uni-US, the duration of general education lasts for one year, so the time length of the
engineering honors program is naturally divided into first year and upper grades. We call it
“1+3” for short. Differently, the duration of FEHP-CN is subjectively divided as “2+2”. This
division is based on the director’s initiative as well as reference to other universities’ experience.
For example, “Yuanpei Program” at Peking University in China is a good example of honors
program which highlights general education in the first two years. In the view of the director of
FEHP-CN, one year is not enough for students to complete the first period of the honors program.
That is because the total credit hours in the lower grades are pre-occupied by compulsory lessons
of ideology and politics as well as foreign language, and FEHP-CN remarkably highlights
intensive study of mathematics, which is relatively time-consuming. The program tracks of
CoEHP and SAE are shown in Figure 1. More details of the curriculum system of FEHP-CN will
be discussed in later sections.
In this section, we also highlight a number of features of FEHP-US and FEHP-CN. Both FEHP-US and FEHP-CN meet the honors students’ need of a different educational experience than anybody else in the first year. They also adopt much smaller classes, set specific requirements for students’ admission and dismissal, and provide portfolios and learning communities. These features have become consensus priorities for both program directors.

Findings of the Central Program Theme

a) Understandings of Honors Student and Program

Both directors believe that honors students are academically superior compared to non-honors students within any given institution. They have the potential to maintain and reinforce their high academic achievements if universities provide well-designed higher education programs for them.
The directors also consider that not only should honors students be tagged as “academically excellent”, but also they need to develop emotionally, socially, and as leaders relative to their non-honors peers.

The director of FEHP-US indicates that the difference between honors students and gifted or talented students is the latter group is defined as somebody who has special capabilities, especially natural abilities in a particular subject or activity without being taught, not just limited in achieving a high standard in completing a university qualification. The director of FEHP-CN accepts the differences between honors students and gifted or talented students, but what he focuses is not precisely defining honors students but developing an honors program that fits for honors students, as well as gifted or talented students. He emphasized three guide principles of implementing an honors program, which consists of the process of how the honors classes are taught, the content that is taught and the product that is how the students share their knowledge.

b) Vision and Mission

On the basis of the background and practical situation of each honors program, both directors state “developing engineering honors students into future leaders” as the program vision. In their opinions, leadership development is considered as a comparatively long-term systematic project for honors students. It may start from first-year engineering honors program or much earlier, stretching back to pre-college experience or extending into professional practice, spanning one’s entire educational experience. When talked about ways to develop leadership, FEHP-CN director decodes engineering leadership into two progressive levels of scientific/technical leadership and charismatic leadership. He believes that technical leadership is the basis of charismatic leadership, so FEHP-US students need to lead in science and technology in the school years by intensive study of mathematics and engineering theories. For the same topic, FEHP-US director acknowledges that they develop leadership through student involvement in design-oriented or project/problem-based learning activities. His research team is conducting research on modeling honors student success, in which they discuss how leadership is taught and made into a personal education experience. The research result will help shape a new FEHP-US course concerning leadership in 2011 spring semester, and finally plan to offer it the first time in the following fall semester. To make the vision more explicit to FEHPs, directors also express their program mission in their own tones. To sum up, three missions are highlighted:

- To continue to ignite the inquisitive nature that honors students have demonstrated in their high school programs
- To nurture honors students to advance their intellectual growth
- To make a community of scholars that is a group of high-achieving students relating to each other so they can help motivate and push themselves
Discussions of the Central Program Theme

In this section we find that directors of FEHP-US and FEHP-CN work out basic agreements on the recognition of honors students and honors programs. They also build a consensus on the vision referring to leadership development and three major missions of first-year engineering honors program. However, when it comes to the concrete methods to reach the vision, their viewpoints differ as design-oriented research study versus mathematics-centered intensive learning.

A reasonable explanation to the similarities is the theory of value chain, which was initiated by Michael Porter to generalize the business activities within the process of creating values\textsuperscript{10}. This theory pointed that a value chain for any product or service extends from research and development, through raw materials supply and production, through delivery to international buyers, and beyond that to disposal and recycling. By mapping this process from start to finish, strategy-makers can better determine where they can capture greater value within the national component of the global value chain. From this theory, engineering leadership tends to be defined as the capability of engineering innovation to integrate the existing value chain, or build new ones, or increase efficiencies within its existing components, in order to occupy the most value-added links in the chain through the whole period.

In fact, the vision and mission of FEHP-US is a response to the current policies of the engineering and engineering education communities in the United States. In 2007, a report named Moving Forward to Improve Engineering Education was published by the National Science Board of the United States. This report pointed out that “changes in the global environment require changes in engineering education”, and “markets, companies, and supply chains have become much more international and engineering services are often sourced to the countries that can provide the best value”, which indicated that the engineering education policy-makers of the United States had already been aware of the profound change in the engineering environment in the background of internationalization and globalization\textsuperscript{11}. Similarly, in 2008, another publication, The Offshoring of Engineering: Facts, Unknowns, and Potential Implications, published by the National Academy of Engineering in the United States further emphasized that engineering education in the United States should strengthen its competitive edge of priority, in order to supply more qualified human resources to ensure that engineering enterprises in the United States play a leading role in the new international engineering environment by taking strategies to keep the most valued-added link and outsource the rest to other countries\textsuperscript{12}.

It is not surprising that China, the fastest economic growing entity in the world has the same ambition as it has the largest engineering education scale in the world. The vision of FEHP-CN represents China’s long and great effort to looking for breakthroughs in developing and upgrading high quality engineering education. This could account for the reason why these two
programs have similar understanding of honors students/programs, and share the same vision to educate future engineering leaders.

The different actions taken by these two programs can be attributed to the reflection of the industrialization level of these two countries. The United States had finished the industrialization process for more than ten decades, and now more attention is paid to engineering innovation, R&D, and explorations of new energy. However, as the workshop of the world, China still stays in the mid-term of industrialization based on its competitive advantage of manufacture-driven economy. The rapid development rate of China’s economy calls for the upgrading of the industrial structure and autonomous innovation of engineering R&D. Mathematics, physics and engineering science are no doubt driving forces.

Findings of the Curriculum System

a) Curriculum Structure

There are a variety of honors courses in FEHP-US, categorized as mathematics, chemistry, physics, engineering, science selective, optional seminar and first-year general education elective. FEHP-US students are required to choose 9 credit hours’ courses (almost equivalent to 3 courses, depending on the credit hours each course takes up) from the courses list. The FEHP-CN courses are classified into 3 categories of mathematics, physics, and English. (See Table 3; note that the course numbers have been changed for the anonymous reason.).

<table>
<thead>
<tr>
<th>Categories</th>
<th>Courses for FEHP-US</th>
<th>Courses for FEHP-CN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics</td>
<td>Honors Calculus I</td>
<td>Mathematical Analysis I</td>
</tr>
<tr>
<td></td>
<td>Honors Calculus II</td>
<td>Mathematical Analysis II</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Advanced Algebra I</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Advanced Algebra II</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Probability and Mathematical Statistics</td>
</tr>
<tr>
<td>Physics</td>
<td>Modern Mechanics (Honors)</td>
<td>Fundamental Physics</td>
</tr>
<tr>
<td></td>
<td>Electric and Magnetic Interactions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Honors)</td>
<td></td>
</tr>
<tr>
<td>Chemistry</td>
<td>General Chemistry (Honors)</td>
<td>--</td>
</tr>
<tr>
<td>Engineering</td>
<td>Honors Creativity &amp; Innovation in</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>Engineering (ENGR 101H)</td>
<td></td>
</tr>
<tr>
<td>Science</td>
<td>General Chemistry (Honors)</td>
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</tr>
<tr>
<td>Selective</td>
<td></td>
<td></td>
</tr>
<tr>
<td>English</td>
<td>--</td>
<td>College English</td>
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<tr>
<td></td>
<td></td>
<td>Oral and Written English</td>
</tr>
</tbody>
</table>
Optional Seminar | First-year Engineering Seminar (Honors) | --
--- | --- | ---
First-year General Education Elective | Fundamentals of Speech Communication (Honors) | --

b) Curriculum Highlight

The most emphasized category in the FEHP-US curriculum system is engineering, in which the core curriculum ENGR 101H is the only first-year honors course with an engineering component. Designed and taught by the director of FEHP-US, ENGR 101H is a design-oriented introductory course that introduces students to the engineering professions through multidisciplinary, socially-relevant content. Students will learn, through experience, the engineering problem-solving process starting from applying engineering fundamentals and basic engineering science concepts to model, analyze, predict, build, and evaluate an object of engineering interest using a design process, the approaches for comprehending engineering systems and generating and exploring creative ideas and alternatives by implementing algorithmic forms of engineering models/problems using the most appropriate computer tools (LabVIEW, Matlab, and Python), and analyses in engineering. Students also learn how to work effectively on a team by developing skills for cross-cultural communication and team management. The director of FEHP-US highlighted that design is the core element and cornerstone of engineering because engineers make things. He believes that there are two advantages to make ENGR 101H a design-oriented course. On the one hand, it keeps FEHP-US students who want to be engineers excited about being an engineer, making ENGR 101H inspires students to get engaged in practical learning experience to solve engineering design problems; on the other hand, it helps students understand the significance of knowledge that they need to learn and will learn in the future.

When compared with ENGR 101, the equivalent course for first-year non-honors engineering students, the director of FEHP-US identified three differences. First, there are more engineering design sessions in ENGR 101H. ENGR 101 spends more time on problem formulation. In ENGR 101H, there are also problem formulation sections, but more attention is paid to generating matrices and modeling in order to create engineering design options. Second, students learn to use many more engineering tools as part of the ENGR 101H course. Software packages are used as tools for setting up engineering models and doing engineering estimations. The last and probably the biggest difference is that ENGR 101H has multiple hands-on design projects that are done throughout the year. With the small size class, FEHP-US students have more opportunities to learn through practice.

The most emphasized category in the FEHP-CN curriculum system is mathematics, which takes up to 62.5% of the whole credit hours. These courses teach pure mathematics knowledge that is
the same as what mathematics students learn--the same course titles, the same credit hours, the same in-class topics, and even the same mathematics textbooks. It is different from what non-honors engineering students learn in mathematics classes in terms of topics studied and approaches to solving problems. The director of FEHP-CN believes it is an advantage to make a solid base of mathematics for any engineering student. He explains that he is an example of an engineer who benefited from mathematics, as he majored in mathematics and finally became an expert of computer and electronic engineering.

For a more comprehensive understanding of the mathematics courses taken by engineering students, Table 4 shows the entire mathematics curriculum systems of engineering programs in Uni-US and Uni-CN, both honors and non-honors. We can see that the Uni-CN engineering honors students study mathematics more broadly, deeply, and much earlier than the Uni-US honors students throughout all four years. In the first year, both honors programs offer calculus courses. For FEHP-US, honors calculus I and II are provided as two successive 5 credit-hour courses. Each course is taught for a whole semester. For FEHP-CN, the equivalent courses called Mathematical Analysis I, II, and III have 5 more credit hours; therefore, they are taught in three semesters in order to introduce broader and deeper calculus knowledge to students. The FEHP-CN students also learn Advanced Algebra I and II in the first year, which is more wide-ranging and complicated than linear algebra that will be taught to FEHP-US students in the second year. Finally, the Uni-CN students learn Probability and Mathematical Statistics, and modern mathematics such as Abstract Algebra and Functions of Real Variables, while the equivalent courses are not included in the Uni-US curriculum system.

Table 4: Mathematics Curriculum Systems of Engineering Programs in Uni-US and Uni-CN

<table>
<thead>
<tr>
<th>First Year</th>
<th>Engineering Honors Program in Uni-US</th>
<th>Engineering Non-honors Program in Uni-US</th>
<th>Engineering Honors Program in Uni-CN</th>
<th>Engineering Non-honors Program in Uni-CN</th>
</tr>
</thead>
</table>
| • Mathematics - Honors Calculus I  
• Mathematics - Honors Calculus II | • Analytic Geometry and Calculus I  
• Analytic Geometry and Calculus II | • Mathematical Analysis I  
• Mathematical Analysis II  
• Advanced Algebra I  
• Advanced Algebra II  
• Probability and Mathematical Statistics  
• Probability and Mathematical Statistics | • Engineering Advanced Mathematics  
• Linear Algebra  
• Probability and Mathematical Statistics |
Discussions of the Curriculum System

In this section, we find that FEHP-US emphasizes engineering design content using modeling as a tool, while FEHP-CN courses emphasize intensive study of mathematics. These findings enable us to reflect further on the starting point of setting up the courses. We want to know what engineering honors students really need to learn in their first-year study.

Considering all of the elements of engineering, first-year engineering honors students definitely have to know fundamentals, and be good at mathematics and sciences. They also require an understanding of the role of modeling, visualizing something for manufacturability (as demonstrated in the hands-on design projects), and gaining interaction and leadership experience in a project team. Among all the curriculum content from an engineering perspective, the first-year engineering honors class is responsible for letting students know and understand the essential key elements of engineering, telling them what it is and how to use it. Undoubtedly, the design-oriented FEHP-US classes follow this approach.

It goes without saying that training sessions of different disciplines concerning mathematics and physics in engineering education are of vital importance, however, these subjects support engineering education but are not the heart of engineering education. It is well recognized that the goal of mathematics education is to train mathematicians. From the history of engineering and the origin of engineering education, we know that engineering education has a close relationship with mathematics elements, but the relationship does not mean that mathematics elements could take the place of engineering education itself. Actually, if the mathematics courses get involved into engineering education, they are no longer pure mathematics courses. They will be modified as “engineering mathematics”. We never deny the importance of mathematics to engineering. What we do is to remind ourselves of keeping the right track. From
this perspective, we need longitudinal research to evaluate the effectiveness of FEHP-CN mathematics classes. One possible way is to track FEHP-CN students and let them look back and evaluate the courses after five, ten, twenty or more years, in order to find whether they believe mathematics courses benefit themselves and what courses really inspire and push them in advance. However, that takes time.

**Conclusion**

This study compares two First-year Engineering Honors Programs (FEHPs), one from the United States and one from China, through interviews with both program directors. Similarities and differences between these two programs are represented on three levels: program overview, central program theme, and curriculum system. We find that both programs are part of four-year engineering honors programs. They have some similar specific characteristics such as small-sized classes, intensive faculty interactions, entry requirements, and honors learning communities. Both directors have a similar understanding of honors students and programs, and they set up the same program vision for educating future engineering leaders. The most significant difference is found in the curriculum system. The program from the United States offers students a variety of classes. The engineering honors class highlights design by using computer modeling tools and hands-on activities. By contrast, the program from China provides students with a series of mathematics-oriented classes in order to form a solid foundation for future study. Reasons of similarities and differences are also discussed in this study.

This study also provides opportunities for future research. Firstly, given the emphasis that both FEHPs place on educating future leaders, we notice that there is the dearth of research on providing models of engineering leadership or engineering student success. Secondly, we find that both programs in this study are affiliated with a broader honors program which lasts for more than one year. This calls for research on correlations between first-year and upper division engineering honors programs. A lot of perspectives such as curriculum system and administrative structure in different levels can be discussed to improve the whole program. Thirdly, as mathematics is highlighted in the first-year engineering honors program in China, more research is expected to investigate what kind of mathematics engineering honors students really need, how mathematics can be taught to these students, and how they benefit from mathematics courses. Finally, this study presents rich case studies of two programs from two different countries. More research can be conducted to determine if the differences between these two programs are true on a larger scale—if the findings are representative of programs across the United States and across China.
References


7 The Ministry of Education launches the Excellent Engineers Educational Program. http://202.205.177.9/edoas/website18/24/info1277271957556124.htm


11 National Science Board. (2007). Moving Forward to Improve Engineering Education. 1-3


Appendix A

Interview Questions（访谈问题）

1 When was the honors program launched? Could you please explain the reasons or introduce me some background to launch this program at that time?
（项目是何时启动的？当时启动这个项目有什么背景，是基于哪些方面考虑？）

2 What kind of engineering education theory or principle is the program based upon? What are the teaching aims and education objectives of the project? How were they determined?
（这个项目的教育理念以及对学生的培养目标分别是什么，这些主要是基于哪些工程教育方面的理论和原则？）

3 What measures are taken to support and achieve the set goals，and how are they finally determined? Were they ever adjusted, revised or modified in the process of program’s implementation?
（项目是通过哪些具体措施和方法支撑和达成预定的培养目标，这些措施是如何通过决策最终确定的，在实施过程中是否它们进行调整、修正和更改？）

4 Please give a brief introduction of the ongoing honors program, such as the number of faculty and students involved per year.
（请介绍一下目前项目的运行情况，每一届有多少学生参与，多少老师参与。）

5 Compared to the curriculum structure of the general first-year engineering program, what classes are added, intensified, or highlighted, or what are the major differences in curriculum between the general program and the honors program? On the level of course content, which parts are added, intensified, or highlighted?
（在课程结构上，本项目的哪些课程得到加强，或者说，它们与普通的工程专业新生课程相比有何不同？同样，在涉及具有工程内涵的课程内容层面，哪些内容得到了加强？）

6 Compared to engineering honors programs in other universities, what are your program’s characteristics? What are the problems of the program we need to handle in the coming future?
（与其他学校类似的项目相比，本校的特色在哪里？目前项目在运行中有没有什么亟待解决的问题？）

7 Are there any data analyses or quantitative measurements concerning to what extent the students involved in the honors program could achieve the set teaching objective?
（对于参与本项目的学生在达成培养目标方面，有没有进行测量或数据分析？）

8 How important do you think leadership is for honors students?
（您觉得培养实验班学生的领导能力重要吗？重要性体现在那里？）

9 As leadership is one of the most important education objectives for honors students, what do you think are the elements of engineering leadership, and what do we do to develop their leadership in our program?
（既然培养学生的领导力是本项目的一个重要的理念和目标，您认为工程领导力有哪些基本的要素，在项目中我们又是如何培养学生的领导力的？）