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Defining the Engineer of the Future
Rose-Hulman Institute of Technology, Harvey Mudd College,
and The Cooper Union for the Advancement of Science and Art

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Abstract

This paper takes a closer look at the engineer of the future. Growing competition from countries such as China and India will change the method of teaching engineering to students. We researched three schools that have become national leaders in engineering education: the Rose-Hulman Institute of Technology, Harvey-Mudd College, and The Cooper Union for the Advancement of Science and Art.

Through our research we have discovered that prestigious universities may choose many different ways to educate the engineers needed to be successful in today’s world. Whether specializing in general engineering, putting an emphasis on “soft skills,” or cultivating problem solving and critical thinking, these three schools – Rose-Hulman, Harvey Mudd, and Cooper Union – are leaders in their field because they are innovative and continually review their curricular offerings and adapt to current world and business conditions. All three schools are able to competently educate the “engineer of the future.”
Introduction

The engineer of the future. Many debate as to what type of attributes this person should have, but everyone agrees that what was considered to be a well-equipped engineer decades ago is not the same as what a well equipped engineer is today. According to one statement, “the mechanical engineering profession is changing from the branch of engineering the encompasses the generation and application of heat and mechanical power and the production, design and use of machines and tools to one that addresses societal concerns through analysis, design, and manufacture of systems, at all size scales…These changes address micro-and nano-scale devices and systems, advances in bio systems, information technologies, and environmental issues.”¹ Others feel that mechanical engineering is changing, but do not yet have such a precise explanation as to what it will become. A 2005 release by the National Academy of Engineering (NAE) Committee on Engineering Education (CEE) stated that in the past “engineering and engineering education were reactive, responding to change” and that today “rapid change signals that it is time to reverse the paradigm.”²

While Americans may be divided as to what to do with engineering as a whole, or with and individual engineering disciplines, it is clear that with growing competition from countries such as China and India, the old “tried and true” method of teaching engineering to students must be changed. For this reason, we researched three schools that have become national leaders in engineering education: the Rose-Hulman Institute of Technology, Harvey-Mudd College, and The Cooper Union for the Advancement of Science and Art.

An Overview: Rose-Hulman, Harvey Mudd, and Cooper Union

These three highly selective and successful universities share many attributes. Each university has been consistently ranked among the nation’s elite in engineering education by *U.S. News and World Report* for the past several years. Their continued excellence in the academic realm helps them to stand apart from the rest of the field. Each school is highly selective and boasts a relatively small student body. Ranging from 700 to 1,900, these universities utilize small classroom settings to help drive home engineering education to their students.

Because of its distinction as being consistently ranked the number one specialized engineering school in the country for the past several years, we chose to use Rose-Hulman as our anchor school. The following pages will display our findings.

### Table 1: Comparison of Rose-Hulman, Harvey Mudd, and Cooper Union

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<tr>
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<th>Rose-Hulman</th>
<th>Harvey Mudd</th>
<th>Cooper Union</th>
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<tbody>
<tr>
<td><strong>Enrollment (2005)</strong></td>
<td>1,904**</td>
<td>704*</td>
<td>972*</td>
</tr>
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<td><strong>Location</strong></td>
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<td><strong>Engineering Specialty</strong></td>
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<td>“General” Engineering</td>
<td>Mechanical Engineering</td>
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<td><strong>National Rankings</strong></td>
<td><em>U.S. News &amp; World Reports: Top Engineering Program at Non-Doctoral Institutions</em></td>
<td><em>U.S. News &amp; World Reports: #2 in same category</em></td>
<td><em>U.S. News &amp; World Reports: #3 in same category</em></td>
</tr>
<tr>
<td><strong>Students (%) Who Pursue Graduate Study (2005)</strong></td>
<td>15%**</td>
<td>49%**</td>
<td>35%**</td>
</tr>
<tr>
<td><strong>Full-Time Faculty</strong></td>
<td>161*</td>
<td>93*</td>
<td>215*</td>
</tr>
<tr>
<td><strong>Average Starting Salary</strong></td>
<td>$51,500 (2004)**</td>
<td>$58,000 (2005)**</td>
<td>$50,000 (2005 approximation)**</td>
</tr>
</tbody>
</table>

*Data taken from Thomson Peterson’s College Guide


The Rose-Hulman Institute of Technology (RHIT) was founded over 132 years ago in the year 1874, and was then called Rose Polytechnic Institute. In 1971 the school was renamed Rose-
Hulman Institute of Technology, after the Hulman family’s generous donations to the institution. RHIT sits on more than 200 acres in Terre Haute, Indiana, where it serves as home to 1,904 students. RHIT’s challenging and flexible curriculum attracts students from all fifty states, including Alaska and Hawaii, providing degrees in engineering, science, and mathematics. This institution was chosen for study because it holds a very interesting niche among engineering schools. The focus at Rose is extremely heavy on academics. Students acknowledge that their “workload requires 110 percent” and say that campus life “is spent mostly studying and always worrying if we haven't.” What makes Rose unique, however, is the philosophy of the school. All 1,904 students at Rose are taught by qualified professors, rather than TAs, and the incredibly demanding curriculum is trumped only by the personal relationships between students and teachers. The president of the university is known to sit and eat lunch with students, and teachers routinely invite students over for dinners. This personality and accessibility rounds off the students in more motivating and creative ways, allowing Rose-Hulman Institute of Technology to succeed in its mission statement of graduating mechanical engineers who are technically competent, effective in practice, creative, ethical, and mindful of their responsibility to society.

Harvey Mudd College was founded in 1955 as the liberal arts college of engineering, science, and mathematics for the other four members of the Claremont Consortium. Its young age and membership in a consortium of more traditional liberal arts colleges affords unique opportunities for the 700 men and women who are matriculated at Harvey Mudd. The curriculum reflects this unique position through its broad requirements and heavy research and design emphasis.

The Cooper Union for the Advancement of Science and Art was founded in 1859 by Peter Cooper, a well-known industrialist and philanthropist. Located in Lower Manhattan, Cooper Union

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provides full scholarships to every undergraduate student that is accepted on merit alone.

Engineering is taught through the Albert Nerken School of Engineering. The Nerken School of Engineering offers undergraduate Bachelor of Engineering programs in Civil, Chemical, Electrical, and Mechanical Engineering. Cooper Union also offers a Bachelor of Science program in Engineering and a Master of Engineering Program. 5

All three schools share a number of impressive rankings awarded by national college ratings organizations. For the past seven years, U.S. News and World Report has ranked RHIT as the number one engineering institution whose highest degree is a bachelor’s or master’s. Rose-Hulman has also been cited in many other prestigious college review guides, such as the Princeton Review, Peterson’s Competitive Colleges, and The Fiske Guide to Colleges. In 2004, the Kaplan/Newsweek College Guide listed RHIT as one of the 12 “Hot Schools” in the country. The Princeton Review and U.S. News and World Report consistently rank Harvey Mudd among the top undergraduate colleges in the U.S., and the Princeton Review’s rankings also illustrate the high quality of faculty that the college attracts: Harvey Mudd is number 14 on “Professors Get High Marks” and number 5 on “Professors Make Themselves Accessible.” Finally, Cooper Union is consistently ranked as one of the top specialty schools in the nation by the Princeton Review and U.S. News and World Report.

With just under 1,000 students, and a seven to one student/teacher ratio, Cooper Union is a university where students are able to build personal relationships with their professors and use these relationships to gain further knowledge in the fields of engineering, architecture, and art. Likewise, RHIT is composed of 161 full-time faculty members, 99% whom have a Ph.D.; all of these faculty were selected primarily on their ability to teach and area of expertise. This focus on quality faculty is one of the driving forces behind Rose-Hulman. As one student describes, “The quality of instruction at Rose-Hulman is incredible. Rose is unique among the top engineering schools in that it is

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primarily a teaching, not research, institution.” This philosophy permits many of the RHIT professors to conduct research in their field, without the pressure of it as a requirement, allowing the professors’ primary focus to remain on the students. Furthermore, all classes are taught only by these qualified professors, rather than TAs or graduates students. One student stated, “I was never taught by a TA,” and reiterated the focus on undergraduate education by saying, “Even the president of the school teaches classes!”

This community feel is shared by students at Mudd. The school’s small size allows students a chance to “get to know ALL of your profs, to the point where they walk by you and say hello to you by name,” comments one student (interview 3/1/2006). “They’re not out to fail half of the people in a class. On the contrary, they want you to do well and succeed. If a professor is concerned about your progress (or as I learned from personal experience, attitude as well) in a class, he or she will often approach you and try to work with you to make things better.” Students acknowledge that sometimes Mudd feels too small, but that having four other colleges nearby provides a large pool of students with whom to socialize, as needed.

Graduates of RHIT who decide to begin their career path immediately have nearly 90% career placement annually, while roughly 15% of graduates every year move directly to graduate schools. The challenging nature of the school, however, is illustrated in the graduation rate of 81%. Students constantly stress the difficult nature of the RHIT programs, saying, “they [academic challenges] can run us ragged and it’s tough sometimes having any life outside the classroom. But that’s also where our school shines.” One student continues, “People are incredibly supportive when you have rough weeks or months even, and they support you in what could be heavily competitive environments.” One recent graduate stated, “It felt like family where everybody pulled for each

other… People would even help each other at interviews for jobs they were both applying for. It was a very unusual atmosphere.”

A relatively high number of Harvey Mudd graduates go to graduate school programs—in 2005, the number was 49% of graduates—perhaps because of the desire to gain further specialized knowledge in one field, an opportunity missing from their undergraduate course of study, as, at Harvey Mudd, no specific engineering departments or majors exist. Rather, students study “General Engineering” and receive their Bachelor of Science degree in the same subject. For the 51% of students who enter the business world, the average starting salary is $58,000.8 None of the 12 students interviewed planned to pursue graduate study, and all felt that their undergraduate education was sufficient—and actually preferable—for entry into business. Furthermore, they felt that their general engineering curriculum and alumni networking contacts provided resiliency against the outsourcing threat. No students worried about jobs they might fill being transferred overseas.

Students at Cooper Union share similar demographics and attitudes to those at Mudd. In 2005, 35% of engineering graduates opted to continue their education in graduate school.9 It should also be noted that many graduates from the Albert Nerken School of Engineering do not enter into an engineering field in graduate school. Graduates have reported studying law, English, and psychology among other things. Cooper Union’s geographical location makes it a prime target for major companies looking to recruit young talent. Of the students that did not opt to immediately pursue a graduate level education, 98% were employed full-time in the first six months following graduation. Over 80 companies recruited students from Cooper Union in 2005. A group of alumni from 1997-2005 have reported their starting salaries to average $67,000

9 http://www.cooper.edu/admin/career_services/eng.html
and their current salaries averaged out to $77,000. Both students that were interviewed planned to search for employment rather than attend graduate school. They also were not worried about their chances for obtaining and retaining a secure position, even with the recent influx in outsourcing among American companies. “I am not worried about losing a job once I have it; I am more worried about not knowing what job to take,” stated one student.

Evolving Curricula

For the purposes of this paper, the focus will be on the Mechanical Engineering programs offered at the representative schools, where applicable; Mudd, of course, does not offer a specialized degree. The academic focus of RHIT is divided into 15 degree programs, Economics being the closest thing to a humanities-based major. Nearly all 161 faculty members teach within these majors; however, RHIT’s distinctive curriculum allows students time to pursue interest in humanities courses and so has roughly 20–30 professors to teach such subjects. Interestingly, the first class accepted at RHIT consisted of 48 students, chosen from 58 applicants, and all but four of these pioneers chose Mechanical Engineering as their major. From that day in 1883, the Mechanical Engineering program has grown in both students and faculty to what it is today. Even in the last five to ten years, RHIT has been growing in accordance with the rapidly changing engineering environment upon which it is so closely relies. In recent years, much of the school’s focus has been on two key themes: pursuing international opportunity and producing stronger dynamic engineers.

RHIT has been working to improve its curriculum requirements over the past decade in an attempt to create more qualified engineers for the constantly changing market, stressing the development of dynamic engineers, rather than simply transactional engineers. The term “dynamic engineer” refers to individuals “capable of abstract thinking and high-level problem solving using

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10 The Cooper Union for the Advancement of Science and Art. [http://www.studentsreview.com/NY/CUrASA.html](http://www.studentsreview.com/NY/CUrASA.html)
scientific knowledge. These engineers thrive in teams, work well across international borders, have strong interpersonal skills, and are capable of translating technical engineering jargon into common diction.”

One key strength of a dynamic engineer is the ability to adapt to environmental changes. U.S. engineers are faced with many difficulties, including globalization and outsourcing of jobs to India and China. In the face of such adversity, engineers must not only be technically aware in their field – as a transactional engineer would be – but also be able to re-educate themselves about new material and horizons. As one student stated, “Most importantly, Rose taught me how to learn. After I graduated, I felt I could have gone into any field I chose.”

This adaptability of Rose Hulman graduates allows them the prestige they will acquire as they start their careers, and it is fostered by the innovative curriculum students at RHIT follow.

Similar to the struggle for international opportunity at RHIT, the school’s size limits the overall diversity for curriculum. With fewer students, course offerings are limited; however, diversifying the available courses remains an integral part of the developing curriculum. It seems then, that RHIT is forced to compromise between offering unique courses to specific majors, and having to be efficient with courses by using the same course throughout all applicable majors. Unique course offerings would allow principles of general engineering and mechanical engineering to be taught throughout a student’s life at the school, integrating real life companies and ideas and allowing for a dynamic approach to engineering education. Many engineering programs are focused on the opposite however — a multitude of generalized classes that teach technical skills in a straightforward way. RHIT struggles from being forced down the latter road, yet through careful selection of professors and students, they maintain a level compromise between individuality and technical learning.

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12 Student Review – Rose Hulman Institute of Technology
In reference to the mechanical engineering department, RHIT states, “To be effective and successful, [the students] must be aware of the roles of engineering and science in solving complex technological and social problems as well as of the impacts of social and environmental factors on engineering activities such as design. To foster this awareness, the curriculum allows the student an unusually wide choice of social science and humanities electives and emphasizes the links between society and engineering through courses such as Engineering Systems Design.”

As seen in Figure 1, RHIT curriculum requirements allow, and strongly encourage, participation in electives outside of a student’s major, as well as in-major electives that will contribute to opening a student’s views on his/her subject. In these ways, RHIT is fighting their environmental limits by using their curriculum as a major tool in developing more dynamic oriented engineers. Furthermore, RHIT engineers gain not only knowledge, but a sense of excitement for their field. As Joseph King, the technology training manager and co-op/internship coordinator for General Electric’s Consumer & Industrial Division said, “Rose-Hulman graduates talented engineers that really have a passion for engineering.”

Overall, the changing school philosophy, driven by their curriculum, has faired well for RHIT graduates. Graduates who received their diploma in May 2005 saw benefits of more recruiters on campus, increased demand for them in the job market, and increased salary offers. Rose-Hulman’s Director of Career Services and Employer Relations, Kevin Hewerdine, stated that on-

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13 Rose-Hulman Institute of Technology, Department of Mechanical Engineering - [http://www.rose-hulman.edu/me/](http://www.rose-hulman.edu/me/)
campus recruiting increased 20% in the past year. The amount of students who had taken or received offers by commencement also increased 4% since last year. Rose Hulman President John Midgley stated, “Their aggressive recruiting of our seniors is strong validation of the quality and value of a Rose-Hulman degree.”\(^{14}\) Salaries offered to graduates were also recorded to have increased three percent to seven percent greater than the $51,500 average salary offered in 2004, showing further proof that RHIT is continuing to improve the quality of its education, and the desirability of its graduates to employers.

Mudd’s curriculum, which is often praised for its innovative, hands-on approach to learning, is as much a selling point to students as it is a major detractor. While students praise the quality of their education as being one of Mudd’s best assets, many question the quantity of work required of them. Students note that “you’ll find yourself taking twice as many classes as your peers at other colleges” (interview 3/1/2006) and that “Mudd’s academics are a little harsher than I was expecting. High school didn’t prepare me at all (interview 3/1/2006).”

Professor of Physics Thomas Helliwell submitted a proposal in July of 2005 that called for a slight reduction in the number of core required classes in an attempt to ease the program’s rigor and to change students from being “exhausted and dispirited” into being “energized and excited about learning.”\(^{15}\) The proposal has met criticism from both students and faculty members, however, who feel that a reduction in required core courses would cheapen the education. Still, some believe there’s always room for improvement. Comments one student, “I think it’s too early to know whether those curriculum changes will be put into use. Some changes are probably in order – our school is only 50 years old, so we’re still evolving (interview 2/28/2006).” Another student


comments, “Mudd is hard, at times brutally so. But if you survive the experience, not only will you feel a sense of accomplishment, but you will have probably also completed the hardest four years of your life. Anything afterwards will be easy by comparison (interview 3/1/2006).”

The current Harvey Mudd curriculum, which is in the process of a three-year curriculum review, serves to educate students across a broad range of math and science subjects while also featuring a heavy humanities focus. Currently, all Harvey Mudd students follow a “technical core curriculum” that is taken freshman year, along with one or two engineering courses. The required core spans a broad curriculum in a total of 22 different courses in chemistry, computer science, mathematics, biology, physics, the humanities, and engineering concepts. Students complete the technical core in their sophomore year, after which they declare a major and follow the required courses path for their major.

The chart of required courses for the Engineering major is at right in Figure 2. In addition to the major requirements, Engineers are also required to take 12 humanities courses which must fulfill these divisions: two writing-intensive classes taken in the first

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16 Based on Information and Diagrams in the Harvey Mudd Department of Engineering Handbook.
year; two courses each in Arts and Literatures, Humanities, and Social Studies; two seminar courses; five departmental “on campus” courses; and four to five courses within one specific subject area, two of which must be beyond introductory courses. The distribution requirement, therefore, all but forces students to pick their minors from within the humanities. Most students do not seem to mind assuming a minor in the humanities, although many do not like the distribution requirements themselves. Mudd’s place in the Claremont Consortium allows students to concentrate in fields ranging “from Dance to Russian” and everything in between, although, “the limiting factor in this setup is the five required on-campus classes,” reports one student (interview 3/1/2006). Another reports that “foreign languages are very hard to take at [Harvey Mudd] since they are usually offered at Pomona College and meet 5 times a week in the morning (interview 3/1/2006).” One student who did choose to go the language route remarks, “My concentration is Chinese, and my Chinese class is far and away the most time-consuming class I have (interview 3/2/2006).” Business classes, however, do not count towards the humanities requirement or the technical elective, which “largely discourages” students from taking such offerings as E202 Engineering Management.

To many Harvey Mudd students, the entire thrust of their curriculum is geared towards engineering management. The General Engineering degree, according to the students interviewed, lends itself to managerial and business training. One student raves that “the most significant thing that sets engineers graduating from Harvey Mudd apart is their preparedness for work in the industry… [the curriculum] teaches students how to think (interview 2/28/2006).” Another comments, “The broad base of engineering requirements here ensure that a Mudd graduate is not only capable to perform whatever task it is that they’ve chosen to do, but also guarantees that they’ll be able to communicate their needs to other people in the field, leading to an overall increase in productivity (interview 3/1/2006).” Agrees another student, “Companies are requiring greater
numbers of interdisciplinary engineers recently and the general education is very useful for that” (interview 3/1/2006). Yet another states that “from the very first engineering class you set foot in, you are presented with how things work when dealing with a client, a budget, etc. One thing Mudd education seems to do very well is teach us how to learn what we need to do a given job” (interview 3/1/2006).

The curriculum at Cooper Union is also very well-rounded. According to the Engineering School Dean, Eleanor Baum, “We feel that American engineers need to be more creative. We do this by a curriculum heavy in project based learning” (interview over e-mail). The Albert Nerken School of Engineering introduced a new curriculum to the class of 2007. The new curriculum increased the number of electives in humanities/social sciences that a student needed to graduate. This amount of humanities/social sciences courses is uncommon among many engineering schools. The reason behind this increase was to improve students’ interpersonal, business, and expression skills. Dean Baum goes on further to state, “We emphasize the need for flexibility in curricula, room for electives and individual interests. Electives are also offered in business management, entrepreneurship, and management of technology. The new curriculum also allows students to pursue tracks of specialization if one of the four major programs that are offered is not for them. These tracks of specialization include Computer Engineering, Signal Processing & Communications, Electronic Systems & Materials Engineering, and most recently Bioengineering.¹⁷

The curriculum requires a minimum of 135 credits to be eligible for graduation. Students are allowed to substitute up to twelve credits of required courses with pre-approval, provided that the courses that are substituted are in an engineering discipline. If students choose this particular path, they are able to add to the electives that they already have and pursue a minor, with all of the credits taken (substituted and elective) counting towards graduation.

The current Mechanical Engineering curriculum at Cooper Union is designed to give students a strong base in mathematical and scientific knowledge while allowing students to foster their creativity and expression skills. Required courses span chemistry, mathematics, physics, computer science, and humanities. Students do not choose their area of concentration until their junior year. Prior to their junior year, students are required to complete 24 courses as part of an introductory Foundation Program. The Mechanical Engineering student curriculum following major declaration can be seen in Figure 3.

While the faculty feels that Cooper Union’s curriculum is necessary to prepare engineers with the tools needed to be successful in today’s society, the students have a different opinion. One student feels that the workload at the university is “unnecessarily high.” He continued to say, “I feel like I am constantly doing work and studying. Whenever I am not working on a project or studying I am nervous because I start to think that I should be doing something.” He says

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<tr>
<th><strong>Junior Year Credits</strong></th>
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<tr>
<td><strong>Fall Term</strong></td>
</tr>
<tr>
<td>ESC 130 Engineering Thermodynamics 3</td>
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<tr>
<td>ESC 140 Fluid Mechanics and Flow Systems 3</td>
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<tr>
<td>ME 100 Stress and Applied Elasticity 3</td>
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<td>ME 151 Feedback Control Systems 3</td>
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<td>ME 161 Instrumentation and Measurement 3</td>
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<td><strong>Spring Term</strong></td>
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<tr>
<td>ME 101 Mechanical Vibrations 3</td>
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<tr>
<td>ME 130 Advanced Thermodynamics 3</td>
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<tr>
<td>ME 142 Heat Transfer 3</td>
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<td>ME 162 Experimentation 2</td>
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<td>ME 312 Manufacturing Engineering 3</td>
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<td><strong>Total Credits Spring Semester</strong> 17.0</td>
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<th><strong>Senior Year Credits</strong></th>
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<tr>
<td>ME 120 Design Elements 3</td>
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<tr>
<td>Me 140 Gas Dynamics 3</td>
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<td>ME 163 Mechanical Engineering Projects 3</td>
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<td><strong>Spring Term</strong></td>
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<tr>
<td>ME 164 Capstone Senior Mechanical Engineering Design 3</td>
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<td>ME 320 Mechanical Design 3</td>
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</tr>
<tr>
<td><strong>Total Credits Spring Semester</strong> 15.0</td>
</tr>
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</table>
that students sometimes feel overburdened by the amount of work required to be a student at Cooper Union.

**Special Programs**

All three institutions have established special programs to enhance the “dynamic” quality of educating students and to complement classroom instruction.

*Rose-Hulman Institute of Technology (RHIT)*

RHIT has taken many recent efforts to increase international awareness among its students. The school has increased its study abroad programs in the past decade, now offering a variety of programs in countries such as Germany, Ireland, and Hungary. Most notable, however, is that RHIT has fostered a sister school relationship with a Japanese school, the Kanazawa Institute of Technology. RHIT students are offered a six-week summer program at Kanazawa in Japan, focusing on immersion into the Japanese culture as well as education in basic engineering principles. In 2004, RHIT even declared in a written objective entitled, “Objective 4.3. Global”, that they wanted to instill in their graduates an “ability to recognize the impact of global societies on citizens and professionals.”

Efforts such as this allow RHIT to maintain their modernized education and enable them to deliver highly qualified and well-rounded graduates into the work force.

*Harvey Mudd College*

Harvey Mudd offers a unique opportunity for students wishing to combine the rigorous engineering curriculum with a more broad-based economics focus called the 3-2 Program. A joint venture with Claremont McKenna College, the 3-2 Program allows students to spend three years at

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Claremont McKenna and then transfer to Harvey Mudd for two years. At the end of five years, successful candidates receive both a Bachelor of Arts in Economics from Claremont McKenna and a Bachelor of Science in Engineering from Harvey Mudd. The program is designed to meet the needs of students who expect “to work in management and executive capacities in engineering and technology, either in industry or in government.” The percentage of students enrolled in the program is not disclosed, but program literature stresses that various degrees of bureaucratic approval are necessary before official enrollment, thus lending the appearance that actual enrollment is negligible.

Harvey Mudd also features two unique courses: E4, the freshman-level design class, and the Engineering Clinic, taken for 3 semesters during the junior and senior years. E4, which was first introduced in 1995, “focuses on the very early stages of design, before highly technical details come into play” and involves learning “how to choose among different alternatives and tasks” instead of learning technical know-how, according to Professor Clive Dym, the creator of the course and the Fletcher Jones Professor of Engineering Design. In all, Dym seeks “to introduce conceptual tools to the students, tools to help a student organize his or her creativity.” In Dym’s course, students work on solving real-life problems as presented to them by nonprofit companies. One student interviewed for this paper described E4 as being where “they essentially threw projects at us and said ‘design—go!’”

The Engineering Clinic program also functions on providing real-life problems to students. Clinic, developed in 1963, was an attempt at combining and adapting “elements of cooperative education, the engineering practice school, and the medical school’s clinic-based, team-centric, open-

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22 The Fundamentals of Skinning a Cat.
ended-problem-solving experience.”  In order to get projects, the school turned to industry for help, and placed a fixed, break-even fee upon their services (the fee in 1998 was $38,000). Today, the fee helps motivate students to a higher level of excellence in problem solving than would otherwise be evidenced on a regular class project. Dean of the Engineering School Anthony Bright comments, “It’s not an insignificant investment from a company,” so students must “show that they have put in a professional approach to solving the problem… The motivation for [students], building something which is actually going to go into production, is terrific.”

Because the content of the Clinic courses changes every year based on the projects presented to students by industry, the entire process is very dynamic and is closely correlated to trends in business. For example, the aerospace industry dominated most Clinic projects in the 1980s, but the 1990s brought a broader range of projects to Harvey Mudd, including many computer projects towards the height of the dot-com era. Today, Clinic programs range to reflect the increasingly globalized outlook of companies and sometimes feature collaboration with outsourced units and engineers in other countries.

In all, Dean Anthony Bright estimates that Clinic creates roles “which encourage the cooperation, negotiation, management and communication skills necessary for solving the new set of challenges…in the new environment in which today’s professional engineers find themselves.”

Clinic also helps students, in his estimation, in “preparing for their future role as professional engineers, sharing problems, communicating concepts, seeking consensus, accepting help and

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25 Some Schools Encourage Collaboration

26 “Student, Faculty and Liaison Roles in the Engineering Clinic Program at Harvey Mudd College.” [http://fie.engr.pitt.edu/fie96/papers/429.pdf](http://fie.engr.pitt.edu/fie96/papers/429.pdf)
criticism…[in] in the realities of preparing for a society where working in teams is the norm.”

Students interviewed agreed with Bright’s assessments of skills gained. One remarked, “The Clinic program provides a real corporate client whose requirements must be met and whose bureaucracy must be dealt with” in an opportunity usually missing from more traditional educations (interview 3/1/2006).

Current and future trends in education at Harvey Mudd show the curriculum shifting towards offering more integrated courses. After winning a National Science Foundation grant in 1999 for the Integrative of Research and Education, departments at Harvey Mudd have been working to increase the number of interdisciplinary course offerings. Educators have used the award to revamp the physics and chemistry introductory lab requirements, focusing on turning them into a project-based, team-based experience that is taught by a team of biology, chemistry, and physics professors. This new series of interdisciplinary courses, called the ID Lab and introduced in 2000, will, for the meantime, act as a supplementary option to the introductory labs and will eventually replace them.

Cooper Union

In order to further prepare their students for life in the competitive engineering field post graduation, Cooper Union has implemented the LEAP (Leadership in Engineering and Advancing the Profession) program. According to the program web site, LEAP’s goal is to “cultivate the professional and interpersonal skills of engineering students and to enhance their leadership potential in both college and the workplace, thereby advancing the profession of engineering.” However, the LEAP program is not mandatory; it is an extra-curricular program that gives students the

27 “Student, Faculty and Liaison Roles in the Engineering Clinic Program at Harvey Mudd College”
28 http://www.dof.HMC.edu/hww/aire/Description.pdf
opportunity to experience a more well-rounded educational process and to grow their leadership skills while at Cooper Union.

The LEAP program is concentrated in six different areas: diversity and gender, professional and global experiences, communication, arts and humanities perspectives, communication, experimental learning, and teaching and service. These six concentrations are intended to interconnect and promote self-discovery and leadership.

The LEAP program consists of three-hour workshops. The program is designed to introduce students to issues in leadership. According to one description, “They involve inter-active experimental techniques – simulations, film, improvisations, discussions, physical challenges, role-playing, case studies, guest(s), and dramatic scenarios – all designed to make learning a personal discovery.” The LEAP program has a point system in which students are rewarded for attending workshops and seminars. Once enough points are attained, students may receive a Leadership Certificate. This Certificate can be used on resumes as a way to display to recruiters the skills that students learn that aren’t directly related to an engineering discipline.

Cooper Union also has a program that they have named CONNECT (Cooper's Own No Nonsense Engineering Communication Training). “It consists of a series of intensive workshops supported by seminars to provide an on-going, regular exposure to communication issues for undergraduate engineering students, starting in the freshman year and continuing through their senior year.” The workshops advance from fundamentals to more intensive subject matter as a student progresses through the program. CONNECT also consists of workshops for professors that have an emphasis on teaching and implementing advanced communication in the classroom.

31 LEAP: Leadership in Engineering Advancing the Profession. Judith E. Lyczko.
The faculty at Cooper Union believes that advanced communication skills are essential to being successful in the global economy. The mission statement for the programs states, “The need for skilled communicators increases daily as technologies become "smarter" and more user-friendly, disappearing under the surface of everyday office environments. The ability to conduct convincing face-to-face presentations and virtual long-distance videoconferences, as well as to communicate successfully over the telephone or Web, is necessary for success in the global economy. It is important to not only be a technically competent engineer, but also able to communicate that technology to a wider audience.”

Students at Cooper Union feel that the CONNECT program is helpful in the fact that it gives them the opportunity to cultivate skills that their normal curriculum may not focus on. When questioned, one student stated, “It’s funny when you see a person go to their first workshop and they are terrified to talk to people they don’t know, then, a couple seminars later, they are the best person in the seminar when it comes to talking to others.” The CONNECT program aims to ensure that every participant has the ability to be not only a highly competent engineer, but also a highly competent communicator.

CONNECT is not the only tool Cooper Union utilizes to improve the communication skills of its engineers. According to Dean Baum, “We encourage a study or research experience in another culture, learning languages… We also teach a design course in partnership with foreign universities, working together in global teams and communicating by Internet, phone, and video conferencing.” Through this type of learning, students are able to not only learn how to communicate with their American counterparts, but also learn how to communicate with engineers from different cultures all over the world.

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33 Cooper Union School of Engineering: Profession Development Group. [http://www.cooper.edu/engineering/prof_dev.html](http://www.cooper.edu/engineering/prof_dev.html)
The Impact of Globalization

*Rose-Hulman Institute of Technology (RHIT)*

As an institution, RHIT struggles with international opportunity in many ways, primarily due to their small size. With such a small undergraduate program, it is hard for RHIT to earn the worldwide prestige of many larger universities of up to five times their size. In this way, it is also difficult for RHIT to attract foreign professors and potential foreign students. These difficulties are reflected in numbers, where of the roughly 1,600 undergraduate students, only 55 are international, representing only 15 different countries. The mechanical engineering department lists 27 full time faculty members, while only five have international backgrounds (3 of which with are based in Japan), again showing the lack of international influence in the field.

*Harvey Mudd College*

Likewise, in evaluating Harvey Mudd, the overall lack of global influence is striking. For the most part, professors rely upon industry demands to dictate project materials in dynamic courses like E-4 and Clinic, a process that may or may not accurately portray a global influence. In years past, students have designed apparatuses for audiences spanning the globe, including carrying devices for rural villagers in Guatemala, which helps to lend sensitivity to global issues. Additionally, many students feel that their General Engineering degree provides them a useful tool in that they have a breadth of experience with each engineering field, and are better able to understand engineering concepts on the meta-level than their peers who graduate at other institutions—be they at home or abroad. The humanities requirement is also a fundamental achievement in that it forces students to hone communications and presentation skills in addition to technical ones.
One major concern, however, is the lack of depth offered for students at Harvey Mudd. “Some areas of engineering are not widely represented at HMC,” reports a student. “For example, HMC has very few classes in bioengineering, chemical engineering, or environmental engineering, and since these are very important engineering fields, I sometimes believe that HMC students do not have the great opportunities that exist for other engineering students at colleges where the curriculums are different” (interview 3/1/2006). Furthermore, the sheer multitude of requirements makes it impossible for students to take electives other than those prescribed of them in the technical engineering requirements. Should students wish to pursue business coursework, or take electives in an area outside of their concentration, they find it incredibly hard to do so because they do not count towards specific requirements—and the specific requirements of the College and the General Engineering degree account for every possible space in every semester. The outline that students are expected to follow is very rigid and does not leave space for students who wish to pursue areas outside of those for which they can receive credit, namely in business or engineering management courses.

The combination of overall global ignorance with a tightly packed curriculum creates a very dangerous situation in terms of globalization awareness. Professor Sarah Harris thinks that “students don't take [globalization] seriously enough (overall). They just get through the material to try to get through the course instead of trying to deeply understand it and synthesize it. I understand the survival strategy here -- so many courses, so little time -- but in the long-term this is a poor strategy” (Interview over e-mail, 3/9/2006).
Cooper Union

Overall, Cooper Union not only gives students a first-class engineering education, but also provides students with the “soft skills” (communication and leadership) to be successful in the business world post-graduation. Cooper Union continues to be experimental and innovative when it comes to its curriculum. The faculty at Cooper Union believes that the unusual amount of required humanities and electives courses produces engineers that are not only very competent in their field of choice, but also well rounded with the ability to adapt to the changing environment of engineering. Companies have noticed this phenomenon and aided the university in its curriculum advancement. Together, the university and successful companies has created a formula that has helped supply New York City and the rest of the country with first-class engineers for many years.

The faculty at Cooper Union also recognizes the need for students to be competitive not only nationally, but globally. For this reason, the faculty encourages students to spend at least one semester studying or conducting a research project abroad. Dean Eleanor Baum believes that students who study abroad have an advantage over students that do not study abroad because they will have experienced another culture, and will have been exposed to another language first hand. Through this experience they will be equipped with the ability to understand and service cultures other than that of the U.S. Cooper Union also provides a design course in partnership with foreign universities. In this design course, students work together in global teams. The students communicate by Internet, phone, and video conferencing. The faculty at Cooper Union feels that participation in this course gives students the ability to convey messages in languages and cultures other than their own, in turn making them more valuable in the work place.
Conclusion

Through our research we have discovered that prestigious universities may choose many different ways to educate the engineers needed to be successful in today’s world. Whether specializing in general engineering, putting an emphasis on “soft skills,” or cultivating problem solving and critical thinking, Rose-Hulman, Harvey Mudd, and Cooper Union are leaders in their field because they are innovative and continually review their curricular offerings and adapt to current world and business conditions. Innovative special programs, like Harvey Mudd’s Clinic, Cooper Union’s CONNECT and LEAP, and Rose-Hulman’s study abroad partnership, allow students the opportunity to experience the climate of the globalized business world while still in a mainly academic setting. Opportunities such as these create a high desirability for graduates of all three schools from a business perspective, as the focus of all three educations is mainly learning to how think—how to apply given knowledge to unknown situations and devise creative answers. Therefore, despite an overall lack of emphasis on the import of globalization, we feel that all three are able to competently educate the “engineer of the future.”
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