Markets & Management Studies Capstone Course (MMS 190)

U.S. Engineering Education Reports
Duke Engineering Outsourcing Project

Striving to Recruit and Retain the Best and Brightest Engineering Students
Princeton University and University of Illinois at Urbana-Champaign

Jack Cator
Alex Bates

Duke University
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Abstract

The United States needs to commit itself to recruiting and retaining the “best and brightest” students from within the U.S. and around the world in order to secure a bright economic future. The responsibility of implementing this recommendation is shared by American universities, whose main role in attracting the world’s best and brightest is to improve undergraduate engineering education. This study involves the analysis of two universities – the University of Illinois at Urbana-Champaign and Princeton University – to see how leading American educational institutions are responding to these challenges. Our study is currently modelled to compare and/or contrast the approaches taken by a large, public university and a small, private, Ivy League university in pursuing these tasks, or “action items.” This study emphasizes how both UIUC’s and Princeton’s academic models are well-suited to address current and future issues within engineering education.
Introduction

In *Rising Above the Gathering Storm*, the National Academy of Sciences recommends that the U.S. commit itself to recruiting and retaining the “best and brightest” students from within the U.S. and around the world in order to secure a bright economic future. The responsibility of implementing this recommendation – though largely emphasized by the National Academy as being that of federal and state governments – is partly shared by American universities, whose main role in attracting the world’s best and brightest is to improve undergraduate engineering education in several key areas: “offering beyond the classroom hands-on opportunities that connect to the world of work” and “fostering institutional relationships to show students and faculty the pathways to career development”.

This study involves the analysis of two universities – the University of Illinois at Urbana-Champaign (UIUC) and Princeton University – to see how leading American educational institutions are attracting international students, evolving their undergraduate curriculum’s to incorporate invaluable hands-on learning, and committing to excellence in student workforce placement. Our study is currently modelled to compare and/or contrast the approaches taken by a large, public university and a small, private/ivy-league-level University in pursuing these tasks, or “action items.” Both of their engineering schools are ranked in the top ten undergraduate engineering programs by *U.S. News and World Report’s* 2006 Guide to America’s Best Colleges, and both are renowned American educational institutions. This study, however, will emphasize how both UIUC’s and Princeton’s academic models are well suited to address current and future issues within engineering education.

The focus of the project will be centred around four main research “action points.” The “action points” will address different means in which U.S. engineering institutions are preparing
engineering undergraduates to meet the technological and scientific challenges of the 21st century; these “action points” are areas in which we believe universities are seeking to remain competitive. In this study, we will carry out an analysis of curriculum, an analysis of the industries and jobs in which graduates find employment, an analysis of the steps taken to procure the “brightest and best” engineering students, and an analysis of the added value and competitive edge that each university gives its students. When all is said and done, the aforementioned will paint an extremely lucid picture of the potential future of U.S. engineering education and will highlight the emerging standards or principles of excellence in engineering education and practice, especially in the context of growing global competition.

In terms of why the two universities were picked, UIUC’s College of Engineering is targeted in this study not only because of its prestige as ranked by *U.S. News and World Report* (ranked 8th nationally), but also because of its size and its almost unrivalled importance to the American engineering higher education landscape. According to the American Society for Engineering Education’s (ASEE) 2003-2004 report, UIUC’s College of Engineering ranked 6th in the number of bachelor’s degrees awarded (1,127), 6th in total engineering undergraduate enrollment (5,329), 1st in the number of teaching personnel (425), and 4th in engineering research expenditures ($147.4 million). In these areas, only the Georgia Institute of Technology can compare in both prestige and scope. One particular area of interest to the study of UIUC’s program is its Technology and Management Minor – a program designed to educate engineers in the areas of accountancy, business administration, marketing, and finance in order to better suit them to evolving management structures within modern corporations. Another highlight of the school is its Technology Entrepreneur Center, which serves to educate students in approximately the same areas of business as the Management minor (but with a greater emphasis on
entrepreneurship) and to help familiarize “aspiring entrepreneurs with skills necessary for bringing technological innovations to the marketplace”. Lastly, the UIUC study will examine how – through the its Academy for Excellence in Engineering Education (AE3) – the school is reforming its teaching methods and curricula to provide its students with both real-world engineering experience and important connections to industry professionals prior to graduation.

Princeton’s engineering education model, on the other hand, is somewhat different. This is highlighted by the administration’s commitment to ensuring its students’ “mastery of general principles with specific applications. The focus on principles means that students are prepared with a toolbox of fundamental knowledge that can be applied in many different areas.” ¹ The program highlights the same topics of importance in engineering education as UIUC but in varying manners and methods. A much smaller school than UIUC’s College of Engineering, Princeton’s School of Engineering and Applied Science (hereafter SEAS) typically boasts an undergraduate enrollment of about 750 students. In addition to the school’s U.S. News and World Report 7th place ranking for best undergraduate engineering schools in the country, it received the 5th lowest ratio of bachelor’s degrees to teaching personnel (1.2) and the 29th highest expenditures on engineering research ($51.9 million) in the ASEE report. The study will examine the school’s Engineering and Management Systems Certificate program, which, like UIUC’s Technology and Management minor, serves to enable its students to “operate in a global economic system that is characterized by cultural, ethnic, political, and historical variation.”² This can be seen as a means to bridge the gap between engineering and business education and thus provide students with a much broader skill set for the increasingly-complex employment structures of today’s industries. Also similar to UIUC are Princeton’s Field Work and

¹ Peter Bogucki, Associate Dean for Undergraduate Affairs, School of Engineering and Applied Science, Princeton University, Interview (See Appendix 1)
² Ibid
Community-Based Learning Initiative as well as their emphasis on final year Capstone courses, which both serve to connect students with their relevant industries/surrounding communities and provide opportunities for applying classroom theory to real-world experiences and problems.

**Action Areas**

*Curriculum Analysis*

Curriculum analysis is essential to evaluating the standard of engineering education at Princeton. As can be seen from the curriculum outline (Appendix 1) it is evident that Princeton is committed to providing education in fields varying from Chemical Engineering to Operations Research and Financial Engineering. The diversity of departments offered is an immediate advantage to the school as it potentiates study in a great many areas. Each department is further broken down into sub-disciplines that form the basis of an extremely rigorous and thorough engineering education. The end result is a curriculum that offers highly diverse course material to students. The diversity offered throughout the curriculum is symptomatic of the university’s desire to promote “greater integration between the traditional pursuit of technological innovation and broader considerations of public policy and social, economic and environmental concerns.”

The university has revised its curriculum to further this ambition, saying that it hopes to increase the core strengths of the engineering school whilst encouraging interplay with humanities and social sciences, areas that are already renowned for their strength at Princeton. In the words of the Associate Dean for undergraduate Affairs, Peter Bogucki, “Our approach to engineering education emphasizes fundamental science, general engineering principles, and broad applications within a liberal arts context.” It is obvious from this commentary that one of the

3 [http://www.princeton.edu/~seasweb/P_strategic.htm](http://www.princeton.edu/~seasweb/P_strategic.htm)
principal goals of the present curriculum reform is the integration of specific engineering knowledge with liberal arts studies.

This will offer a considerable advantage to the Princeton graduates in terms of ways in which they can add value to any situation. Specific revisions in the curriculum might include the recent “Leadership in Engineering Initiative” that requires integrative approaches across multiple disciplines of engineering education. The revisions are centred on the realization and inclusion of certain core principles, namely “Interdisciplinary Education and Societal Context, Diversity, Real World Experience and Impact.” One student commented, “New courses, tracts, and combined programs are being developed.” Another student remarked, “A course called “High-Tech Entrepreneurship” about leading technological enterprises is highly popular.” The revisions in curriculum show a mature response to the changing global economic environment and a desire to increase the non-tangible skills that give Princeton engineers the competitive edge over many others. Furthermore, they are suggestive of a move to engender interests and understandings outside of the fields of engineering that might not otherwise be considered by engineering students, namely liberal arts. Additionally, the final product will be an individual equipped with the managerial and leadership skills required of a dynamic engineer. The net result is a more well-rounded education that will no doubt endow the student with skills that will justify their higher wages. An ideal example of an area in which Princeton achieves its managerial and leadership training is within their “Engineering Management Systems Certificate Program.” The course equips students with tools for complex decision making problems that arise in engineering and management. It is aimed at three types of students: those interested in preparing for a career in management and consultancy, those in the liberal arts looking to acquire the

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4 Detailed information to be found - [http://www.princeton.edu/%7Eseasweb/P_strategic.htm](http://www.princeton.edu/%7Eseasweb/P_strategic.htm)
5 Questionnaire Response 1 (see Appendix 1)
analytical tools typically used in corporations and governments, and those in the science seeking exposure to analytical methods and potentially careers in management or public policy. In sum, the education is extremely interdisciplinary and very much aimed at looking to integrate engineers into many walks of professional life.

Reform in each of UIUC’s engineering major curricula in the past ten years has been progressive and generally responsive to changing demands in the job market. The school’s approach to reform in this period can be broken down into two main strategies – departmental consolidation and the integration of real-world learning and work experience into coursework. Consolidation is crucial to the College of Engineering’s future. Its large number of highly-specialized majors and considerable size (5,502 undergraduates in Fall 2005) – which are certainly advantages for attracting and enrolling students looking for specialized education – have together posed serious problems for the school’s ability to adapt to new factors and demands in the engineering job market while approaching engineering education with a unanimous and effective institutional strategy.  When asked what the general approach or ideology was to undergraduate education at UIUC, Technology and Management Program Director John Clarke replies:

“I think that’s something that’s probably better answered by the Dean of the college, and perhaps there isn’t really an overall strategy because some of the departments within engineering at the University of Illinois are as big as other colleges on campus and need to have their own strategies. So I’m not sure I could give you a simple answer to that question, nor am I sure I could give you an accurate answer.”

Ilesanmi Adesida, interim dean of the College of Engineering, explains that in the next few years, General Engineering and Industrial Engineering will combine their programs to form the Department of Industrial and Enterprise Systems Engineering, and the Department of

7 http://www.engr.uiuc.edu/about/facts.php
8 Interview with John F. Clarke, UIUC Director of T&M Program
Theoretical and Applied Mechanics (TAM) and the Department of Mechanical and Industrial Engineering (MIE) will merge to form the Department of Mechanical Science and Engineering. Ominously, he goes on to explain, “The goal of these changes is to strengthen the College of Engineering and better position it to sustain long-term excellence—to achieve optimal efficiency, intellectual coherence, and advancement in quality. As we look ahead, change is inevitable. Our supreme task is to lead the change. That is what is required to be the best.”\textsuperscript{9} Clearly, faculty and administrators within the College of Engineering recognize that their institution – currently at the forefront of undergraduate engineering education in the US – will have to undergo serious changes in order to able to adapt to the changing global landscapes of both industry and education. In short, the college’s consolidation strategy is – in part – reformation for the sake of facilitating expectedly increasing future reform.

Consolidation is also evidence of an increasing emphasis on interdisciplinary engineering education due to growing demand in the global job market for “value-added” engineers. The combination of majors ensures that the college will produce graduates with a wider range of engineering-related skill sets and knowledge. Additional measures are being taken to increase a graduate’s familiarity with real-world problems and solution methods, such as the requirement for seniors within the College of Engineering to conduct senior design projects. During the projects, students collaborate with real industry professionals in developing solutions for new products, services, and processes.\textsuperscript{10}

\textsuperscript{9} http://www.engr.uiuc.edu/about/
An Analysis of the Industries and Jobs in which Graduates Find Themselves

In general there are four main areas into which the Princeton engineers typically go: engineering departments of large corporations, finance and consulting firms, graduate school in engineering, and other graduate programs (including medical and law school). The Associate Dean of Undergraduate affairs notes, “After graduation, B.S.E. students head in many different directions and are highly regarded by the top companies and graduate schools.” Graduate School typically comprises 20-25% of the engineering graduates and appeals most to those that want to further themselves in the field of research. Graduates that head for Wall Street to follow careers in investment banking, consulting, or venture capital, to name but a few, tend to do very well and are apparently seldom affected by globalization. According to Warren Powell, Director of the Certificate Program in Engineering and Management Systems, “Most of our students go into finance or consulting. The international competition is primarily in products (e.g. China) or particular types of programming and consulting (India)\(^\text{11}\). These forces do not affect our problem classes very much (perhaps that is why we are so popular here at Princeton).” This certificate program is geared to those with more of an interest in finance and offers tailored courses to suit those interests. It serves as an excellent example of one of the ways in which Princeton is diversifying its engineering program in order to enable students to retain their competitive edge. Those that go into financing typically comprise 25-30% of the graduating class. It seems that of those who are enrolled in the Operations Research and Finance Engineering most end up in finance (see enrollment data (Appendices)). Freshman Schuster Tanger notes that the majority of students head into the financial sector, in either banking or trading. Of the 25-30% who choose that chose to practice engineering in the engineering departments of large corporations, most will be involved in the design and problem solving. Finally, there are those that further their

\(^{11}\) Warren Powell Director Engineering and Management Systems
education in law and medical School (15-20%). As Dean Boguki notes, “An engineering degree from Princeton is a superb foundation for any endeavour” and that engineering students have ended up in professions ranging from CEOs to educators to astronauts. The diverse range of careers chosen by Princeton engineers is a credit to the diversity in the education offered and will be a huge asset to the university as competition from overseas continues to strengthen. In terms of the facilities offered to help students find and secure jobs, all of the questionnaire responders noted that the careers office was an invaluable resource. Tanger remarked that he found his fellow students were a valuable resource, giving him what he described as the “rawest information.”

The curriculum at UIUC’s College of Engineering is not only tailored to the each student’s problem-solving development and experience, but also aids in forming a bridge between academia and their careers. Particularly, the connections that are built with industry professionals during senior design courses introduce students to cutting-edge ideas and issues within specific industries, help them to gain a better sense of their true career goals and interests, and to familiarize themselves with potential colleagues in a positive environment. Other programs within the departments can even act as supplements to design and industry-sponsored projects. The ECE Corporate Connective, for example, explicitly describes its main function as introducing “ECE students – primarily undergraduates – to new technologies, industry trends, and career opportunities.”

Engineering students are also fortunate enough to have their own career center – Engineering Career Services. A large proportion of undergraduate and graduate students take advantage of career center services; according to admissions, 40% of UIUC undergraduate

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seniors have jobs before graduating and 95% of alumni have jobs nine months after graduation\textsuperscript{13}.

In 2005, more than 1500 employers recruited through ECS for full-time, internship, and co-op opportunities. On-campus recruiters conducted a total 8,228 on-campus interviews alone, and the average interviewing graduate received 2.3 job offers. Approximately 20% of graduates in 2005 continued directly into graduate schools.\textsuperscript{14}

Additionally, the average starting salary of a B.S. engineering graduate in 2005 was $52,500, compared to an average $45,700 for B.S. business graduates and $32,500 for BS Agricultural, Consumer, and Life Sciences (ACES) graduates. According to John Clarke, however, the starting salaries of Technology and Management Program graduates are consistently higher than that they’re business and engineering peers. He explains:

“Our engineers are making 10-20% higher starting salaries than their department peers. We have engineers that have gone on to successful careers in non-standard-engineering areas such as investment banking and strategic consulting. Certainly we feel that we see a strong, positive reaction from employers who encounter our students through the job application process. Either employers are already familiar with the program and it resonates well with them or the students are able to articulate what they’re doing, and a lot of what they’re doing in the T&M program is what employers are looking for.”\textsuperscript{15}

An Analysis of the Steps Taken to Procure the “Best and Brightest” Engineering Students

It is undeniable that the students and faculty form the intellectual fabric of the university. That said an assessment of the students, where they come from, who they are, and what they are like will play a major role in the shape and function of the university. If Princeton is to remain as successful as it is at the moment, it must take every step to continue to maintain and or improve the quality of its student population. While there has been an overall decline in the number of

\textsuperscript{13} http://www.oar.uiuc.edu/future/index.html
\textsuperscript{14} http://www.engr.uiuc.edu/about/facts.php
\textsuperscript{15} Interview with John F. Clarke, UIUC Director of T&M Program
degree candidates, those that are female have increased by almost 30, or around 10%, in the past five years. This is an enormous increase, especially considering that neither the total engineering enrollment increased by a significant margin, nor did the liberal arts school enrollment. In fact, many Princeton departments other than women’s engineering saw either stagnation or decline in numbers between the years 2000 and 2005. In detail, between 2000 and 2005, Chemical Engineering saw a large increase in enrollment, especially in the past year; Civil and Environmental Engineering saw a stagnation and moderate decline; Computer Science saw a decline; and Mechanical and Aerospace engineering saw a stagnation. Operations Research and Financial Engineering, however, saw a massive increase, from 79 enrolled in 2000 to 106 in 2005. It is clear in many respects that Princeton is increasing its engineering class size, a positive sign of growth.

One should ask, however, how they attracting the numbers, who they are choosing, under what criteria they are choosing them and, finally, how the university are adjusting their classes and admissions policies? One of Princeton’s most obvious advantages is its huge financial endowment. Peter Bogucki notes that finance is not an obstacle to attendance at Princeton, due to the extremely generous financial aid packages available to students. This is a huge advantage for the university as it breaks down one of the largest barriers blocking many students from higher education – the cost. Mr. Bogucki adds that the university receives many thousands of applications and that the admissions selection process is both rigorous and discerning. Of particular note are the admissions criterion that Mr. Bogucki stresses; that students are assessed on both an academic level and a personal level. The added consideration for personality is an interesting criterion. We believe it to be an extremely valuable one though. In the context of adding value to the engineers skills and when considering the “intangible” skills of an engineer,
an ability to work in teams, an ability to motivate and mobilize people, and an ability to respect and appreciate other cultures and traditions (all of which will be extremely important for the leaders of tomorrow’s world) are all based in one’s personality. They require a degree of extroversion, a sociable outlook and a general comfort with people. A selection process at the admissions level that considers these factors will enable an institution to maximise the potential benefits of these skills.

Another aspect for consideration is the type of student being admitted and the demographic breakdown thereof. The engineering school have developed what they call a vision statement to outline their desired goals and achievements for the next few years, “The vision statement grew out of a year-long strategic planning process that involved more than 750 faculty members, students and staff as well as alumni and leaders from other institutions and industry.” It is, therefore, a well-informed, comprehensive and definitive guide to the future of Princeton engineering. In the engineering school’s vision statement, the main goals for the future are the increased admission of minority populations to encourage racial diversity and the increased admission of females to combat the undeniable male dominance of the engineering field. Both of the aforementioned are critical for a balanced student population that encourages diversity in the thinkers that it has. When asked how Princeton procures the “best and brightest” students, one student remarked that it is quality of the education and the resources available during and after undergraduate education that draw most individuals. Sophomore Eugene Gokhvat comments, saying, “I believe its Princeton’s stellar reputation that secures the best students.” This speaks volumes about the quality of the engineering education and the steps taken to ensure the students are well equipped for the future. The data clearly show that Princeton is moving in the right
direction to increase its numbers, and that those that are admitted are carefully and strategically picked.

There are several resources and programs within UIUC’s College of Engineering that are designed to encourage and support recruitment of minority undergraduate students. One example is the Morrill Engineering Program (MEP), which strives to attract students of underrepresented groups within engineering during their senior year of high school. The program strives to assist minority students with scholarships and financial advice, academic support throughout their studies at UIUC, and exposure to key areas within their major fields of study in an effort to maintain a high level of interest in engineering and reduce the number of students electing to switch out of engineering. A similar program is Women In Engineering (WIE), the aim of which is to “catalyze an environment that supports and inspires women students in the college and to assess and enhance their educational experience, their recruitment to the college, and their retention within it.”\textsuperscript{16} Another important group at UIUC is the Office of International Student Affairs, which serves to support all of the university’s international students with issues pertaining to immigration, English language skills, academic concerns, and even recreational activities\textsuperscript{17}.

Aside from several small diversity programs such as those listed above, though, UIUC and its College of Engineering do not seem to place a particularly high level importance in attracting more undergraduate international students in response to increasing globalization and intercontinental job market integration. In contrast to Princeton, UIUC specifically does not offer undergraduate international students financial aid unless it is done through endowed or private

funding such as that supporting the programs mentioned above. Ironically, though, the number of total undergraduate international students at UIUC has grown at a much higher rate (from about 570 in 1999 to 1,451 in 2005) than the entire undergraduate population (an average annual growth of about 0.5%) in recent years. As can be seen in the undergraduate student enrollment table (Appendix 3), the number of total undergraduate international students is dominated by students from Asian countries, which account for more than 80% of the total pool. Information regarding the number of international students broken down by college could only be located for the 1999-2000 and 2000-2001 school years, where 129 of 570 and 155 of 634 international students (respectively) were studying engineering – between 20 and 25% of the international undergraduate total for both years. Because the undergraduate engineering population accounts for slightly less than 1/5th of UIUC’s total undergraduate population, a far-reaching interpretation of this data could be that if the number of undergraduate international students studying in the College of Engineering roughly mirrors the college’s size within the university, then the possibility exists that the growth rate of the number of undergraduate international students is approximately equal to that of the number of undergraduate international students studying engineering.

An Analysis of the Added Value and Competitive Edge with which each University Equips its Students

"Our vision is to create a school of engineering that will meet the needs of the world today and for the coming decades in a way that would be hard for any other school of engineering to achieve," states Mrs. Maria Klawe, Dean of Engineering at Princeton’s SEAS. It

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18 http://www.oar.uiuc.edu/future/international/finaid.html
19 http://www.ips.uiuc.edu:16080/isss/StudentEnrollment/
20 http://www.ips.uiuc.edu:16080/isss/StudentEnrollment/
21 http://www.princeton.edu/%7Eseasweb/P_strategic.htm
is apparent from the SEAS Vision Statement that the requirements for a 21st century engineer can and will be met. The school is very aware of the challenges that the next generation of engineers will have to face, and the changes in the engineering landscape – most notably, the increasingly interdisciplinary nature of the science. That said, they are taking steps to ensure that their students are informed and prepared at a top level. The most telling example of the school’s mission to produce 21st century engineers is reflected in the following phrase – “If engineering is to become truly engaged in understanding and solving societal problems, its practitioners must reflect society.”22 This to my mind epitomizes the approach required to integrate the understandings necessary if one is to develop a competitive advantage in today’s global market. Of particular note are the five main goals of the engineering school (SEAS) for the next few years: 23

- Achieve top five rankings for all SEAS graduate and undergraduate programs (Recognizing that rankings measure excellence in both education and research).
- Increase diversity in the SEAS student body.
- Broaden interdisciplinary opportunities for SEAS students.
- Improve scientific and engineering education for non-engineers.
- Better prepare SEAS graduates for success in their careers.

These five objectives represent very concisely the manner in which Princeton can best offer its graduates the “added value” that they will need in order to retain the competitive edge in the world. They encompass all that will differentiate them from the “transactional engineer” and enable them to become industry leaders for the future.

All of the aforementioned contribute to the overall goal of “offering beyond the classroom hands-on opportunities that connect to the world of work” and “fostering institutional relationships to show students and faculty the pathways to career development.” Princeton also offers its engineering student the opportunity to Study Abroad. This, we believe, is an invaluable

22 Ibid
opportunity for the students and one that will give them exposure to something totally different. One student comments that the Study Abroad program is “extremely well advertised.” Schuster Tanger notes however, that it is not a process that is necessarily encouraged by the administration; it is simply left as an option and is ultimately up to the students. This is a positive indicator that the university grants its engineers the opportunity to gain exposure to foreign cultures; however, it might consider a more active encouragement of its student to take up this opportunity, as it will ultimately be an experience that will differentiate them from other engineers, endowing them with knowledge and appreciation from another country. It is an excellent way to enable the engineers to “reflect the society,” and the more societies they are able to reflect, the deeper and richer will be the service they are able to offer.

Dean Bogucki sums up the added value of a Princeton Engineer in saying, “…our graduates are adaptable and can think creatively and innovatively. A Princeton engineering grad might not know the exact model number of pump to use in a particular application, but they would know (1) there’s someplace to look it up and (2) would have good ideas about designing the next generation of pump. Also, our graduates are able to speak and write effectively. Many engineering courses emphasize oral presentations and substantial written reports.” The response here is the result of the overriding perspective that the university has taken with regard to globalization. This perspective, I believe will shed light on the mentality supporting every action area, and should be considered as a useful conclusion to the entire study. The perspective taken is as follows. The response taken by Princeton is one that looks optimistically on the effects of globalization; as Bogucki notes, “we see globalization as an opportunity not a threat.” As a result, their curriculum reform is in part founded on their approach to globalization, which to their mind is a phenomenon to be taken advantage of. The justification thereof lies in the assumption that
increasing offshoring of highly technical labour will liberate more financial resources of U.S. enterprises. This in turn allows firms to hire more U.S. engineering graduates for the purposes of innovation, development and management in domestic markets. This is a mentality that has filtered down to the students; Tanger remarks that, “outsourced labour increases efficiency and leads to a broader, better-reasoned base of ideas and working technologies.” Understanding this mentality is critical in the appreciation of their highly pro-active, mature and sophisticated direction of change in the engineering curriculum.

The most important and beneficial educational initiative for producing dynamic engineers at UIUC is undoubtedly the college’s emphasis and commitment to producing an engineer who – in almost every single area – has legitimate real-world/industry experience before graduating. The benefit of having these types of experiences not only provides recent graduates with an experience-related competitive edge, but also a competitive edge in that they are connected to industry professionals and recruiters far before graduation, making it far easier to beat the competition to an entry-level job at a big-name company (which is itself a competitive “career edge”).

Other than producing graduates with experience and consolidating its departments, though, UIUC’s College of Engineering is doing little to ensure that its graduates engage in interdisciplinary learning during their four years of study. The past decade has witnessed the formation of several specially tailored minor and certificate programs designed to supplement highly-specialized, less-flexible engineering departments. They include the Computational Science and Engineering Option, the Food and Bioprocess Engineering Minor, the Manufacturing Engineering Minor, and the Polymer Science and Engineering Minor, among others. One example particularly relevant to the study is the above-mentioned Technology and

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Management Minor program, which takes equal numbers of business and engineering students and provides them with both fundamental and applied knowledge of their cross-disciplines. The reason for the program’s existence given in the College of Engineering’s 2005-2006 Guide concisely and accurately reflects the basis of the engineering education reform debate:

“In an era when increasing domestic and international competition have caused industry to fundamentally redefine its management structure and its approach to resource management, particularly human resources, the need to hire graduates who can ‘hit the ground running’ is of paramount importance… Companies need engineers who understand market forces and the financial implications of technology investment. They need business majors who understand the technical aspects of process and product development as well as the capabilities and constraints of engineering disciplines.”

According to its director, John Clarke, the program was launched ten years ago in response to growing demand for new skill sets among recent graduates. Since its inception, the program has remained small and focused, looking to maximize its learning experiences through small interdisciplinary teams. When asked whether the program would remain small and optional or if its content might grow to positively influence the education of more or all of the College of Engineering’s students, Clarke replies:

“I think that there are some plans in place to invoke some of the things we’re doing in this program on a broader scale, but we do things that you couldn’t do with all the undergraduates because they cost too much money. We’re going to remain a prototyping shop where we get to try things out so that both the college of business and college of engineering get to learn from us, learn from our experience, and then perhaps replicate some of the things we’re doing outside.”

Clarke raises an interesting point – that a major obstacle in effectively broadening the influence of “niche” programs is often the underestimated cost of education improvement.

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26 Interview with John F. Clarke, UIUC Director of T&M Program
Conclusions

In general therefore, the study finds that Princeton is equipping itself extremely well for the future. In the first place, they are well aware of the changing global landscape. They are conscious of the potential threat from India and China, in terms of outsourcing and graduating engineers, although they have chosen to appraise the situation as potentially advantageous. This is an optimistic and pro-active move on Princeton’s behalf, but one that we believe will pay off in the long term. The curriculum reforms seek to integrate liberal arts perspectives and further encourage interdisciplinary learning, processes that we believe will serve tomorrow’s engineers extremely well. In terms of the jobs and industries currently attracting engineers, the large percentage of graduates looking into finance is a sign that the interdisciplinary nature of the engineering program is – in some sense – working. While it is encouraging to hear of engineers using their new skills sets to go into business work, it must be considered that the opposite diffusion of non-engineering graduates into engineering jobs is minimal, if not non-existent. The fact that Princeton is aware of where its students are looking to work and where they are most competitive, however, is a vast strength for them. Support services in this “action point” also seem to be in place and are well utilized by the student population. In terms of recruiting the “best and brightest” students, it seems that the university has a extremely competent and thorough admissions process that considers many aspects of candidacy, meaning that only the right students will be admitted. Furthermore, it seems from the commentary that the number of applicants is sufficiently high that the university need not concern itself with a dwindling human capital base. Finally, in terms of adding value, the university prides itself on offering more than any other university, particularly in terms of integrating knowledge from a great number of
academic fields. It also has taken an extremely mature response to enabling its students to understand societies and solve problems within those particular societies.

The College of Engineering at the University of Illinois has undoubtedly responded to the evolution of the engineering job market using steps that certainly could be beneficial to U.S. engineering graduates everywhere, were they to be implemented and practiced nationwide. The pattern of department consolidation has certainly exemplified the administration’s recognition that the greatest “winners” in a globally integrated educational system and/or job market will be those who are most able to adapt to changing demands and corporate structures. Additionally, the college’s increased emphasis on interdisciplinary studies – mostly between related areas of engineering and to a lesser extent between engineering and other general areas of education – is most assuredly a response to employers’ calls for new, dynamic skills sets. Current job market placement at UIUC is largely aided by the collaborative relationships the college and university have successfully developed with a large number of key players in the industry.

To that extent, it has absolutely offered “beyond the classroom hands-on opportunities that connect to the world of work” and fostered “institutional relationships to show students and faculty the pathways to career development”. The college has taken critical steps to encourage and increase diversity among its undergraduate population, but aside from vague and incomplete data on the number of total undergraduate international students, we have little evidence to suggest that the proportion of undergraduate international engineers has increased in the past decade, and even less evidence to suggest that the college even acknowledges the importance of attracting “the world’s best and brightest”. Finally, the school’s ability to create value-added engineers is largely limited to its success in giving students real-world experience. Requiring interdisciplinary studies of all students and implementing them across all fields has proven too
costly and too complicated a reform for the large, public institution to incorporate into their immediate educational plans.

One of the most important takeaways from our conclusions on the study is the idea that U.S. undergraduate engineering schools tend to react to issues like globalization and increasing engineering job competition in one of two ways. They either view globalization as a threat that requires reform in order to stay competitive, or view it as a positive force that, if harnessed correctly, will positively affect U.S. undergraduate engineering education. It seems fairly clear that Princeton’s administration approaches the argument from the second view. Their reforms tend to deal with “lighter” interdisciplinary fields – such as cultural awareness, foreign language skills, economics, public policy, etc. – suggesting that the most important added value to an engineer’s overall skill set is an ability to understand and work with different cultures and interest groups around the world. On the other side of the spectrum, UIUC uses the first approach. The general response from the school’s representatives pertaining to the issue of globalization and its effects on the engineering job market is that it is a “threat” that needs to be responded to by taking precautionary and/or preventative measures to ensure competitiveness. UIUC’s reforms tend to deal less with addressing cultural and societal awareness and much more with teaching an engineer how to forecast the cash flow projections of a development project or how best to market and distribute a newly developed product.

Another important takeaway is the idea that instead of there being just two possible steps of reforming curricula (reforming or not reforming) in U.S. engineering schools with shifting demands in the global engineering job market, we find that there are generally three types of reform. Administrators can chose not to reform their programs, to reform by giving undergraduates new but optional value-adding study areas, or to reform by implementing more
drastic, all-encompassing measures. Overall, Princeton seems to approach reform with the third strategy, sticking to a general approach to the issue and making a unified step (mentioned above) in the direction they view as optimal. UIUC, on the other hand, is largely hindered by multiple factors that are keeping it from quickly and/or drastically adapting to changing demands. As a result, it is forced to develop “niche” study areas that cater to the different interests of many small, specialized fractions of the whole undergraduate population. Other reforms made by UIUC, though, (such as its real-world/industry experience initiative and its pattern of departmental consolidation) could be viewed as all-encompassing reforms similar to those of Princeton but that are simply less definitive and identifiable.

However you interpret the changes made at either school, one point is clear – both institutions recognize the changes taking place in the U.S. engineering job market, and both have responded to the issue with approaches most suitable to their environments and resources. Neither approach to the issue and neither method of making reform outweigh the other in every situation or setting. Each school must be treated individually, taking into account its size, funding, range of interdisciplinary interests among engineering students, location, and current competitive advantage. In thinking about globalization, the immense, imminent, and unpredictable changes in the global economy, and the resulting effects on the global job market that will unavoidably call for different types of workers, it seems illogical to guess that united, overall reform to curricula will not play a much larger role in solving education issues. Clearly, this implies a great deal of work to be done by each institution in planning its future, and while the study concludes that Princeton University and the University of Illinois have both done well in taking actions appropriate for their individual circumstances, no engineering school in the
country will be able to comfortably tread water while neither its domestic nor foreign counterparts ever leave the drawing board.
Appendix 1: Questionnaires, used with Students and Faculty of Princeton University

Student Questionnaires

Questionnaire 1: Schuster Tanger

Name*: Schuster Tanger
Year: Class of 2008

The Issue
In Rising Above the Gathering Storm, the National Academy of Sciences recommends that the US commit itself to recruiting and retaining the “best and brightest” students from within the US and around the world in order to secure a bright economic future. Meanwhile, Chinese and Indian engineering universities are allegedly graduating more engineers than their US counterparts. Furthermore, these engineers can be hired by multinational corporations to do outsourced work that may have gone to US engineers, but for considerably lower salaries. Should companies seeking engineers look overseas and succumb to the effects of globalisation; benefiting from the cheaper labour? Or should they continue to hire domestic labour at a premium knowing that US engineers have intangible benefits that warrant their being paid more? This questionnaire is seeking information in response to growing public concern that the US is losing its competitive advantage in the field of engineering education. The goal of this study will be to assess the extent to which this is correct/incorrect and to what extent measures have been put in place to combat the supposed losses.

1. If there is an overriding approach to engineering education at Princeton what would it be? What areas of study and disciplines are concentrated/emphasized most?

I am an Operations Research and Financial Engineer. Among other topics that are briefly dealt with in the curriculum, finance and mathematics are the most important subject areas. In particular, optimization techniques, stochastics processes, and securities pricing are big issues. The approach to engineering in my major is predominantly interactive problem-solving with a preceptor (i.e. “TA”).

2. Does Princeton have advantages, as a smaller Ivy League university, over larger state schools? If so what are they?

Yes, certainly. I imagine the class sizes are smaller. I’ve gotten the opportunity to know some of my professors personally, and the lectures often feel conversational, even if the professor does most of the talking. Also, in terms of tackling the job market, Princeton feels more community-oriented: people know one another and try to help out.

3. What steps does Princeton take to secure the “Brightest and Best” students – domestically and internationally?

I actually applied as a BA and switched into the engineering program after my first semester as a freshmen. Therefore, I do not feel well equipped to answer this question.
4. Are globalisation and the increasing number of overseas engineers affecting approaches to engineering education at Princeton? In what ways? Can this be seen as a threat to American (specifically Princeton) engineers’ competitiveness?

I don’t think so. The best engineers still seem to be having minimal problems getting the best jobs. In some senses, outsourced labours increases efficiency and leads to a broader, better-reasoned base of ideas and working technologies.

5. What changes and developments have been made with regard to curriculum in response to globalisation? Are the changes radical or simply adjustments?

   a. Have any measures been taken to focus on producing ‘dynamic engineers’?

      The school of engineering is obviously revising their programs to remain on the forefront of current knowledge and technology. However, I don’t think any of these measures have been that radical.

   b. To what extend are engineers required/encouraged to engage in interdisciplinary learning?

      Very much so. I specifically did not apply to a school like MIT, because, even though I’m in the school of engineering, I still have access and am encouraged to participate in on of the finest liberal arts programs in the world.

   c. Do engineers have the opportunity to study abroad? Is this encouraged by the administration?

      The opportunities are certainly available, but I think the faculty leaves it up to the students. I don’t have much interest in studying abroad, because I don’t want to be away from my friends and am more than content here academically.

   d. Do engineers gain exposure to leadership/teamwork/managerial skills?

      Not particularly. My classes are mostly based on weekly problem sets. Very infrequently do we work in large groups or make public presentations.

   e. In what fields do Princeton engineers generally head into post graduation? Which companies are most active in their recruitment/employment of Princeton Engineers?

      I will speak for my major, which is predominantly math and finance. Therefore, the majority of students head into the financial sector, either banking or trading. Due to the rigorous math element of the program, there’s seems to be a stronger inclination towards trading, especially in hedge funds.

   f. What facilities does the school provide to help its students find and secure jobs?
Not much as far as I can tell. While we receive plenty of emails regarding career opportunities, I find my fellow students to be my most useful resource. They seem to give the rawest information.

g. What are the features of the Princeton engineer that would give employers the added value that they would be paying for in their salary as compared to an engineer from India or China for example? What are the main ‘tools’ that Princeton equips its engineers with that enable them to increase their productivity compared to engineers in the US and abroad.

I don’t know.

* Please feel free to answer anonymously. Should you want any responses given to be “off the record” please highlight the phrase and note that you would not like it specifically attributed to yourself. Your requests will be honoured with the utmost sincerity.
Questionnaire 2: Eugene Gokhvat

Name*: Eugene Gokhvat
Year: 2007

The Issue
In *Rising Above the Gathering Storm*, the National Academy of Sciences recommends that the US commit itself to recruiting and retaining the “best and brightest” students from within the US and around the world in order to secure a bright economic future. Meanwhile, Chinese and Indian engineering universities are allegedly graduating more engineers their US counterparts. Furthermore, these engineers can be hired by multinational corporations to do outsourced work that may have gone to US engineers, but for considerably lower salaries. Should companies seeking engineers look overseas and succumb to the effects of globalisation; benefiting from the cheaper labour? Or should they continue to hire domestic labour at a premium knowing that US engineers have intangible benefits that warrant their being paid more? This questionnaire is seeking information in response to growing public concern that the US is losing its competitive advantage in the field of engineering education. The goal of this study will be to assess the extent to which this is correct / incorrect and to what extent measures have been put in place to combat the supposed losses.

1. If there is an overriding approach to engineering education at Princeton what would it be? What areas of study and disciplines are concentrated / emphasised most?

2. Does Princeton have advantages, as a smaller Ivy League university, over larger state schools? If so what are they?

*Smaller classes, accessible teachers.*

3. What steps does Princeton take to secure the “Brightest and Best” students – domestically and internationally?

*I believe that Princeton’s stellar reputation is what secures the best students, and that maintaining that reputation by having world class faculty and facilities is all it needs to do.*

4. Are globalisation and the increasing number of overseas engineers affecting approaches to engineering education at Princeton? In what ways? Can this be seen as a threat to American (specifically Princeton) engineers’ competitiveness?

*I don’t think so considering that the brightest foreign minds still come to America and institutions like Princeton to achieve their full potential.*

5. What changes and developments have been made with regard to curriculum in response to globalisation? Are the changes radical or simply adjustments?
   a. Have any measures been taken to focus on producing ‘dynamic engineers?’
I don’t know what that means, but I know that “Dynamic Programming” is a very popular class in my major, Operations Research & Financial Engineering.

b. To what extend are engineers required/encouraged to engage in interdisciplinary learning?

To a great extent – there is a set of interdisciplinary requirements.

c. Do engineers have the opportunity to study abroad? Is this encouraged by the administration?

Yes, there are advertisements periodically for the more traditional majors to study abroad for the semester. I found that studying abroad over the summer was a better decision give my coursework.

d. Do engineers gain exposure to leadership/teamwork/managerial skills?

Obviously. Homework and projects are generally tailored for team work.

6. In what fields do Princeton engineers generally head into post graduation? Which companies are most active in their recruitment/employment of Princeton Engineers?

My major is unique, but most ORFE majors go into finance or consulting for several years before going to graduate school. Investment banks, hedge funds, consulting firms, and tech firms are active recruiters.

7. What facilities does the school provide to help its students find and secure jobs?

Career Services is great at facilitating the job search.

8. What are the features of the Princeton engineer that would give employers the added value that they would be paying for in their salary as compared to an engineer from India or China for example? What are the main ‘tools’ that Princeton equips its engineers with that enable them to increase their productivity compared to engineers in the US and abroad.

A Princeton engineer will have had more strenuous non-engineering requirements, translating into a more well-rounded education. Princeton students learn from the best professors in the world and come out with a more complete skill set than someone who has attended an engineering vocational school.

* Please feel free to answer anonymously. Should you want any responses given to be “off the record” please highlight the phrase and note that you would not like it specifically attributed to yourself. Your requests will be honoured with the utmost sincerity.
Questionnaire 3: Alex van Hoek

Name*: Alex van Hoek
Year: 2008

The Issue
In *Rising Above the Gathering Storm*, the National Academy of Sciences recommends that the US commit itself to recruiting and retaining the “best and brightest” students from within the US and around the world in order to secure a bright economic future. Meanwhile, Chinese and Indian engineering universities are allegedly graduating more engineers their US counterparts. Furthermore, these engineers can be hired by multinational corporations to do outsourced work that may have gone to US engineers, but for considerably lower salaries. Should companies seeking engineers look overseas and succumb to the effects of globalisation; benefiting from the cheaper labour? Or should they continue to hire domestic labour at a premium knowing that US engineers have intangible benefits that warrant their being paid more? This questionnaire is seeking information in response to growing public concern that the US is losing its competitive advantage in the field of engineering education. The goal of this study will be to assess the extent to which this is correct/incorrect and to what extent measures have been put in place to combat the supposed losses.

1. If there is an overriding approach to engineering education at Princeton what would it be? What areas of study and disciplines are concentrated/emphasised most?

*Problem Solving is the underlying skill that the engineering degree here seeks to develop. For this reason, academic teamwork is encouraged.*

2. Does Princeton have advantages, as a smaller Ivy League university, over larger state schools? If so what are they?

*The small size, and very much undergraduate-focused academic environment mean that full professors do most of the teaching, and all the academic advising. There is also a great student/faculty relationship, based on a shared passion for the subject matter.*

3. What steps does Princeton take to secure the “Brightest and Best” students – domestically and internationally?

*The engineering school is one of the best in the world, and the name does a lot of work. As for specific recruiting programmes – not sure.*

4. Are globalisation and the increasing number of overseas engineers affecting approaches to engineering education at Princeton? In what ways? Can this be seen as a threat to American (specifically Princeton) engineers’ competitiveness?

*The Princeton University motto is: “in the nation’s service, and in the service of all nations”, reflecting the global scope of the university’s, and its students’, ambitions. I have never seen or
felt any reaction, positive or negative, to the increasing number of engineers being educated in Asia.

5. What changes and developments have been made with regard to curriculum in response to globalisation? Are the changes radical or simply adjustments?

a. Have any measures been taken to focus on producing ‘dynamic engineers’?

b. To what extent are engineers required/encouraged to engage in interdisciplinary learning?

c. Do engineers have the opportunity to study abroad? Is this encouraged by the administration?

d. Do engineers gain exposure to leadership/teamwork/managerial skills?

6. In what fields do Princeton engineers generally head into post graduation? Which companies are most active in their recruitment/employment of Princeton Engineers?

1/3 get jobs in the industry, 1/3 pursue graduate degrees in the engineering sciences, and the remaining 1/3 pursue other interests.

7. What facilities does the school provide to help its students find and secure jobs?

An excellent career- services centre, as well as daily emails about upcoming recruiting deadlines etc.

8. What are the features of the Princeton engineer that would give employers the added value that they would be paying for in their salary as compared to an engineer from India or China for example? What are the main ‘tools’ that Princeton equips its engineers with that enable them to increase their productivity compared to engineers in the US and abroad.

The world-renown and highly experienced faculty at Princeton University and its world-class facilities all make the engineering education here at Princeton absolutely superb. We are given a well-rounded education (liberal arts), which doubtless helps us with the other aspects of engineering (i.e. the human side).

* Please feel free to answer anonymously. Should you want any responses given to be ‘off the record’ please high-light the phrase and note that you would not like it specifically attributed to yourself. Your requests will be honoured with the utmost sincerity.
Questionnaire 4: Anonymous

Name*: 
Year: 2009

The Issue
In *Rising Above the Gathering Storm*, the National Academy of Sciences recommends that the US commit itself to recruiting and retaining the “best and brightest” students from within the US and around the world in order to secure a bright economic future. Meanwhile, Chinese and Indian engineering universities are allegedly graduating more engineers their US counterparts. Furthermore, these engineers can be hired by multinational corporations to do outsourced work that may have gone to US engineers, but for considerably lower salaries. Should companies seeking engineers look overseas and succumb to the effects of globalisation; benefiting from the cheaper labour? Or should they continue to hire domestic labour at a premium knowing that US engineers have intangible benefits that warrant their being paid more? This questionnaire is seeking information in response to growing public concern that the US is loosing its competitive advantage in the field of engineering education. The goal of this study will be to assess the extent to which this is correct / incorrect and to what extent measures have been put in place to combat the supposed losses.

1. If there is an overriding approach to engineering education at Princeton what would it be? What areas of study and disciplines are concentrated / emphasised most?

2. Does Princeton have advantages, as a smaller Ivy League university, over larger state schools? If so what are they?

*Yes, as a more selective school, Princeton Engineering alone looks good on a job application. The small class size allows for individual attention, not at the expense of faculty or funding*

3. What steps does Princeton take to secure the “Brightest and Best” students – domestically and internationally?

*Provides a quality education, and provides resources for students to explore their options after graduation.*

4. Are globalisation and the increasing number of overseas engineers affecting approaches to engineering education at Princeton? In what ways? Can this be seen as a threat to American (specifically Princeton) engineers’ competitiveness?

5. What changes and developments have been made with regard to curriculum in response to globalisation? Are the changes radical or simply adjustments?

   a. Have any measures been taken to focus on producing ‘dynamic engineers?’

   *New courses, tracts, and combined programs are being developed*
b. To what extend are engineers required/encouraged to engage in interdisciplinary learning?

*Very much so, all majors require interdisciplinary work.*

c. Do engineers have the opportunity to study abroad? Is this encouraged by the administration?

*The option is available and well advertised, though difficult to take advantage of.*

d. Do engineers gain exposure to leadership/teamwork/managerial skills?

6. In what fields do Princeton engineers generally head into post graduation? Which companies are most active in their recruitment/employment of Princeton Engineers?

   b. *Wall Street, and banking*
   
   c. *Med school*
   
   d. *And respective engineering masters programs*

7. What facilities does the school provide to help its students find and secure jobs?

*Student run organization*

8. What are the features of the Princeton engineer that would give employers the added value that they would be paying for in their salary as compared to an engineer from India or China for example? What are the main ‘tools’ that Princeton equips its engineers with that enable them to increase their productivity compared to engineers in the US and abroad.

*An excellently trained and well qualified engineer, that knows the US culture and how the country operates.*

* Please feel free to answer anonymously. Should you want any responses given to be ‘off the record’ please highlight the phrase and note that you would not like it specifically attributed to yourself. Your requests will be honoured with the utmost sincerity.
Faculty Questionnaires

Questionnaire 1: Peter Bogucki

Name*: Peter Bogucki, associate dean for undergraduate affairs
Department: School of Engineering and Applied Science

The Issue
In Rising Above the Gathering Storm, the National Academy of Sciences recommends that the US commit itself to recruiting and retaining the “best and brightest” students from within the US and around the world in order to secure a bright economic future. Meanwhile, Chinese and Indian engineering universities are allegedly graduating more engineers their US counterparts. Furthermore, these engineers can be hired by multinational corporations to do outsourced work that may have gone to US engineers, but for considerably lower salaries. Should companies seeking engineers look overseas and succumb to the effects of globalisation; benefiting from the cheaper labour? Or should they continue to hire domestic labour at a premium knowing that US engineers have intangible benefits that warrant their being paid more? This questionnaire is seeking information in response to growing public concern that the US is loosing its competitive advantage in the field of engineering education. The goal of this study will be to assess the extent to which this is correct / incorrect and to what extent measures have been put in place to combat the supposed losses.

1. If there is an overriding approach to engineering education at Princeton what would it be?

Princeton’s engineering curriculum combines the mastery of general principles with specific applications. The focus on principles means that students are prepared with a toolbox of fundamental knowledge that can be applied in many different areas. For example, the principles of fluid mechanics apply to the flow of air over an airplane wind, oil through a pipeline, or blood through an artery. A student who masters the basic principles can adapt them to many different and novel situations in subsequent courses and after graduation.

There is also ample opportunity to apply these principles creatively. Each department offers a course in engineering design that teaches students to put the principles into practice by working on one or more projects. Students then take this experience and pursue independent work in their junior and senior years. Independent work is the capstone of the Princeton engineering education. Working closely with one or more faculty members, students choose an engineering problem, design the research required to investigate it, carry out experiments and other studies, analyze and interpret the results, and present their conclusions in a professional manner.

We have just completed a Strategic Plan for the next several years, and it would be helpful for you to look at it to get a better sense of our values and goals:
http://www.princeton.edu/%7Eseasweb/P_strategic.htm and then click on the link to the Vision Statement. (if this doesn’t work from MS Word, go to http://www.princeton.edu/engineering and follow link to “Engineering for a Better World”.) Note: what is called “CETE” in this document is now known as “CIEE”, the Center for Innovation in Engineering Education.
2. What areas of study and disciplines are concentrated / emphasised most?

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<td>Engineering and the Liberal Arts</td>
<td>Programming Languages and Systems Parallel Applications and Systems</td>
<td>Computer Engineering</td>
<td>Solid State Electronics</td>
<td>Energy Conversion and Combustion</td>
<td>Logistics</td>
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</table>

3. Does Princeton have advantages, as a smaller Ivy League university, over larger state schools? If so what are they?

4. What steps does Princeton take to secure the “Brightest and Best” students – domestically and internationally?

Same as everyone else in our league – we get many thousands of applications from the top students nationally and internationally and admit very few after a very discerning and rigorous review of applications. They are very accomplished both academically and personally. We
have very generous financial aid that does not require a loan as a part of the package, so finances should not be an obstacle to attending Princeton.

5. Are globalisation and the increasing number of overseas engineers affecting approaches to engineering education at Princeton? In what ways? Can this be seen as a threat to American (specifically Princeton) engineers’ competitiveness?

We see globalization as an opportunity rather than as a threat for Princeton engineering graduates, and the challenge is not to try to resist globalization or somehow immunize our graduates against it but rather to help them take advantage of the possibilities that it offers. Our approach to engineering education emphasizes fundamental science, general engineering principles, and broad applications within a liberal arts context. As a result our graduates do not stay long in the sorts of technical positions that might go overseas or they avoid them in the first place. Engineering innovation, research, and development, as well as the management of complex technological enterprises are things that the U.S. does very well and for which there will always be a domestic demand. Indeed, sending mid-level technical work offshore to take advantage of favourable labor markets and wage structures can free up the resources of American enterprises to hire MORE skilled engineering graduates for innovation and design here in the U.S.

6. What changes and developments have been made with regard to curriculum in response to globalisation? Are the changes radical or simply adjustments?

We would like our engineering graduates to know how to operate in a global economic system that is characterized by cultural, ethnic, political, and historical variation. In many respects, we’ve been doing that for a long time at Princeton, with our emphasis on the liberal arts and international affairs, but we now would like to make it more explicit and a stronger expectation that Princeton students will have a global vision. See the Strategic Plan to which I linked above for a lot more detail. But it’s not a radical change, but an institution-wide effort to promote international experiences, language study, and regional studies.

a. Have any measures been taken to focus on producing ‘dynamic engineers’?

I don’t understand what this expression means. We don’t use it as a slogan here.

b. To what extend are engineers required/encouraged to engage in interdisciplinary learning?

All engineering is interdisciplinary, since disciplinary borders define relatively arbitrary organizational units of scholarship rather than actual boundaries. Having said that, the major frontiers for innovation in biotechnology, nanotechnology, and information technology are all explicitly interdisciplinary, and thus yes, we will be encouraging a lot of interdisciplinary work over the next decades. See the Strategic Plan.

c. Do engineers have the opportunity to study abroad? Is this encouraged by the administration?
Yes, Princeton engineering students have opportunities to study abroad. In addition to an exchange program with Oxford, engineering students have studied recently in Australia, New Zealand, Chile, South Africa, the United Kingdom, and Denmark. The student chapter of Engineers Without Borders has carried out a project in Peru, and other students have done fieldwork and research in Kenya, Greece, and Italy. The administration strongly encourages foreign study. Most of the faculty are supportive, although a few remain sceptical of its value. I am personally a strong supporter of studying abroad.

d. Do engineers gain exposure to leadership/teamwork/managerial skills?

Most engineering departments organize their design and capstone courses into team projects which require negotiation to make decisions about options. A course called “High-Tech Entrepreneurship” about leading technological enterprises is highly popular. Engineering students take leadership roles in student organizations, athletics, and other activities throughout the campus.

7. In what fields do Princeton engineers generally head into post graduation? Which companies are most active in their recruitment/employment of Princeton Engineers?

After graduation, B.S.E. students head in many different directions and are highly regarded by the top companies and graduate schools. Some are attracted by engineering research (about 20-25%), and thus go to graduate school for an advanced degree. Others pursue the practice of engineering (about 25-30%), which can range from the design of products to the solving of problems. Many go to work in the fields of commerce and finance, for example in investment banking, venture capital, and management consulting (about 25-30%). The remainder attend medical school or law school, start a business, or do whatever they wish. An engineering degree from Princeton is a superb foundation for any endeavor. The value of Princeton’s approach is reflected in the achievements of B.S.E. graduates, who are leaders not only as designers and researchers but also as CEOs, educators, lawyers, teachers, doctors, and astronauts.

8. What facilities does the school provide to help its students find and secure jobs?

Career Services office has staff member who works with School of Engineering and Applied Science; SEAS organizes annual Science and Technology Job Fair; SEAS Undergraduate Affairs Office receives and disseminates information about jobs and internships; recruiters may also have ties to specific departments.

9. What are the features of the Princeton engineer that would give employers the added value that they would be paying for in their salary as compared to an engineer from India or China for example? What are the main ‘tools’ that Princeton equips its engineers with that enable them to increase their productivity compared to engineers in the US and abroad.

I repeat the response to question 1: Princeton’s engineering curriculum combines the mastery of general principles with specific applications. The focus on principles means that students are
prepared with a toolbox of fundamental knowledge that can be applied in many different areas. For example, the principles of fluid mechanics apply to the flow of air over an airplane wing, oil through a pipeline, or blood through an artery. A student who masters the basic principles can adapt them to many different and novel situations in subsequent courses and after graduation.

So our graduates are adaptable and can think creatively and innovatively. A Princeton engineering grad might not know the exact model number of pump to use in a particular application, but they would know (1) there’s someplace to look it up and (2) would have good ideas about designing the next generation of pump. Also, our graduates are able to speak and write effectively. Many engineering courses emphasize oral presentations and substantial written reports. Since all Princeton engineering students do an independent research project (sometimes several), they have the confidence that they can independently identify a problem or question, figure out the analytical techniques and data needed to address it, carry out those analyses, interpret the data, and present the results in a professional manner. As a result, most rise to leadership positions in whatever they decide to do after graduation. Most of our graduates do not plan to be doing the same thing at age 40 that they did when they graduated at age 22.

* Should you want any responses given to be ‘off the record’ please high-light the phrase and note that you would not like it specifically attributed to yourself. Your requests will be honoured with the utmost sincerity.
### Appendix 2a: BSE Undergraduate Degrees, 2000-2005

**B.S.E. Undergraduate Degree Candidates by Class and Gender**

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*Prepared by the Office of the Registrar October 19, 2004.*

### Appendix 2b: BA Undergraduate Degrees, 2000-2005

**A.B. Undergraduate Degree Candidates by Class and Gender**

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<tr>
<th>CLASS</th>
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*Prepared by the Office of the Registrar October 19, 2004.*
### Appendix 3: Princeton Undergraduate Enrollment Concentrated by Department

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Revised October 10, 2004 by the Office of the Registrar, Princeton University.
Appendix 4: EMS Certificate Pre-Requisites and Requirements

B.S.E. students are eligible for admission to the program once they have completed the engineering school core program (or its equivalent):

1. Mathematics through Mathematics 202
2. Physics 103 and 104
3. Chemistry 201
4. One course in computing at the level of Operations Research and Financial Engineering 201 or Computer Science 126 (effective 2005, ORF 201 is no longer offered).

The certificate is available to A.B. students who have completed

1. The two science and technology with laboratory courses.
2. Mathematics through Mathematics 202, and
3. One course in computing (typically Computer Science 126)