ESTABLISHING A TECHNICAL UNIVERSITY FOR WOMEN

An Interactive Qualifying Project Report

submitted to the Faculty

of the

WORCESTER POLYTECHNIC INSTITUTE

in partial fulfillment of the requirements for the

Degree of Bachelor of Science

by

Lindsay A. Bulso

Date: May 3, 2005

Professor George D.J. Phillies, Major Advisor

Executive Summary

The purpose of this project was to develop a non-coeducational technical university in Southern New Hampshire that will be about the same size as Caltech. We believe that such a school would successful in recruiting women and increasing the number of female engineers and scientists.

- Studies have shown that women at single-sex schools have more self-confidence, choose more masculine areas of study, and pursue doctorate degrees in these areas more extensively than do women at coeducational schools.
- Less than 16 percent of the women who apply to, but do not enroll at, the Seven Sister Colleges, must attend our model Institute.

Our model includes:

- 13 academic departments: Biology; Bioengineering/ Biomedical Engineering; Chemical Engineering; Chemistry; Civil & Environmental Engineering; Computer Science; Earth, Planetary, and Astronomical Sciences; Electrical Engineering; Humanities & Social Sciences; Management; Mathematics; Mechanical Engineering; and Physics.
- 250 – 300 full-time faculty members, about 1200 undergraduates, and about 800 graduate students.
- Academic and other buildings with total construction costs of about $560 million including:
- An academic building, with a library, which is about 1.4 million square feet, and will cost about $330 million to build.
- Administration and support space of about 62,500 square feet, which will cost about $16 million to build.
- A campus center of about 80,000 square feet that will cost about $20 million to build.
- About 1 million square feet of parking space, which will cost about $40 million to build.
- Residential facilities that will total about 660,000 square feet, and will cost about $155 million to build. These dormitories were designed based on the fact that in 100 years, people will be wealthier than they are now, and the standard of living will be different.

The goal was for the dorms to be acceptable 100 years from now. The dorms will have large single rooms with private full-bathrooms.

- An endowment of about $1.8 billion, with $30 million each year to pay faculty.
- A detailed plan for admissions requirements.
- A freshmen general studies curriculum that includes Calculus I and II, Physics I and II, Chemistry I, Science Writing, one other Science course, and one other Humanities course; and one Humanities course per semester for four years.
- Residential facilities that will total about 660,000 square feet, and will cost about $155 million to build. These dormitories were designed based on the fact that in 100 years, people will be wealthier than they are now, and the standard of living will be different. The goal was for the dorms to be acceptable 100 years from now. The dorms will have large single rooms with private full-bathrooms.

Abstract

It is our belief that the number of female engineers would increase if there were a technical university for women. Studies have shown that women at single-sex schools have more self-confidence, choose more masculine areas of study, and pursue doctorate degrees in these areas more extensively than do women at coeducational schools. In this project, we developed a model for a first-rate women's technical university. This model includes the academics of the school, as well as construction of the campus.

Table of Contents

Section I. Introduction 1

Section II. Background 3

A. Technical Universities 3

B. Women's Schools 6

Section III. Academics 10

A. Departments at the model Institute 11

B. Department Sizes 17

C. Curriculum for First Year Students 32

D. Academics Conclusion 38

Section IV. Admissions 39

A. Market Data Summary 40

B. Admissions Standards and Application Process 41

C. Admissions Conclusion 50

Section V. Campus Structure 51

A. Academic Building Using John Miller's numbers 52

B. Academic Building: A Second Approach 58

C. The Library 61

D. The Campus Center 62

E. Campus Structure Conclusion 63

Section VI. Student Life 64

A. Location of the Model Institute 65

B. Living on Campus 69

C. Student Life Conclusion 72

Section VII. Funding the Institute 73

A. Construction Costs 74

B. Professorships 77

C. Endowment 78

D. Funding Conclusion 79

Section VIII. Conclusion 80

Section I. Introduction

In comparison to the number of male engineers, there are few female engineers. Most engineering schools are primarily male and most women's schools are Liberal Arts schools. Perhaps if there were a technical women's university specifically for women, the number of women who become engineers and scientists would increase. This paper is dedicated to determining the necessities of a new first-rate women's technical university.

The proposal here was to create a first-rate technical university such as the Massachusetts Institute of Technology or the California Institute of Technology. In order to design a first-rate institute, it was first important to ask: What makes a school first rate? The goal is for each science and engineering department at this model Institute to be ranked in the top ten nationally. What does MIT have that schools like WPI lack? Once the characteristics of a first-rate institute were determined, we were able to design our model.

The first step of this project was to do background research on first-rate technical universities. The top five engineering schools in the country are Caltech, MIT, Princeton University, Stanford University, and the University of California, Berkeley. Using information about which departments are found at these schools, the departments necessary for the model institute were determined. Then information was gathered about the top ten schools in the United States for each of these academic fields. This information was used to determine how large each department needs to be.

After the requirements for first-rate academics had been determined, other important characteristics of the model Institute were determined. These characteristics include the location and structure of the campus, student life on and around campus, and funding for the institute. These characteristics were determined from information about the top five engineering schools as well as the five "seven-sister schools" that continue to be primarily undergraduate schools for women. These schools would be the model institute's competition for attracting students.

The final thing to consider is how to develop a new school. The model institute has been designed to include everything that it will need to become a first-rate institution, but perhaps it does not need to be full-size initially. It may start small, with fewer faculty, and a smaller building, and grow with time. Also, building a new school requires a large amount of money. We researched different foundations that would be possible sources of funding.

Section II of this paper provides background information about the five engineering schools and the "Seven Sister" schools mentioned previously. Each school is discussed briefly, to illustrate the type of schools that our model was designed after.

Section III of this paper explains the academics at our model Institute. It shows which departments are included in our model, and why. It also shows how we determined the number of full-time faculty members, undergraduates, and graduate students in each department in our model. Also developed in this section is the core curriculum that will be followed by all students.

Section IV of this paper discusses the admissions at our model Institute. This section explains the admissions requirements, such as standardized test requirements and high school preparation. It also explains the admissions process, which includes the application components and deadlines. Also in this section, we provide information that shows there is a market for a women's school.

Section V of this paper talks about the campus structure of our model Institute. In this section we design the academic building for our model in two ways. We first design it using numbers and a method suggested by John Miller, the director of Physical Plant at Worcester Polytechnic Institute. The second time, we used numbers that would produce larger offices and laboratories. In this section, we also designed the library and campus center for our model.

Section VI of this paper discusses the student life aspect of our model Institute. This section includes the location of the school, and what the housing is like.

Section VII of this paper explains the financial side of our model. This section includes a cost summary for the construction of the campus and Professor salaries. This section also explains how we determined the necessary endowment for our model.

Section VIII of this paper is simply a conclusion to the project, and Section IX is an executive summary of our results.

Section II. Background

The goal of this project was to design a model for a first-rate women's technical university. Therefore, information was needed about other first-rate technical universities, as well as other women's schools.

Technical Universities

To determine which engineering schools to use for our model, we used the National Survey of Graduate Faculty. This survey ranks schools for different departments, by giving their faculty a score. Therefore, for each department, we were able to use these tables to determine which schools had the top ten departments in the country. We found the top ten schools for many science and engineering departments, and found that some schools ranked in the top ten for many departments. We assumed that these schools were first-rate science and engineering institutions, and we used information about these schools to develop our model. The five science and engineering schools are the California Institute of Technology, Massachusetts Institute of Technology, Princeton University, Stanford University, and the University of California, Berkeley. We used information about these schools to determine which departments our model should include, and what core curriculum courses should be included. We will now provide some background information about each of these schools.

California Institute of Technology

Caltech is a small science and engineering school located in Pasadena, California. It has about 283 full-time faculty members, 896 undergraduate students, and 1276 graduate students[1]. There are many different departments for the different fields of science and engineering, and one combined department for Humanities and Social Sciences[2]. This is clearly a school that is dedicated to educating students in science or engineering, which is the purpose of our model Institute. Although students at Caltech choose to major in many different fields, there is a core

[1] Caltech At a Glance - http://www.caltech.edu/at-a-glance/
[2] Caltech homepage - http://www.caltech.edu/

curriculum that all students must complete. We used this core curriculum to help develop that of our model.

Students at Caltech live in one of 8 student houses. "They're not dorms, and they're not frats; a closer description might be 'self-governing living groups' "[3]. Each house is different from the others. Incoming freshmen choose which house they would like to be a part of.

Caltech offers a variety of activities for students to participate in. These include NCAA Division III Intercollegiate sports, many club and inter-house sports, music, theatre, and about 100 other clubs and organizations[4].

Massachusetts Institute of Technology

MIT is another first-rate science and engineering school. Although MIT does have a School of Humanities, Arts, and Social Sciences, and a School of Management[5], the scientific and engineering fields are the school's primary focus. The 2004 – 2005 enrollments show that about 85 percent of students at MIT are in the School of Science or the School of Engineering. Only about 13 percent are in the School of Management or the School of Humanities, Arts, and Social Sciences[6].

Like Caltech, MIT also has a core curriculum that must be completed, regardless of the major chosen by the student. MIT calls this curriculum the General Institute Requirements, or GIR's.

The housing at MIT is similar to that of Caltech. The school uses a system of 11 Institute Houses, which have their own mail services, laundry facilities, vending machines, TV lounge, weight room, game room, music room, computer quick stations, and computer connections in all students' rooms[7].

---

[3] Caltech, Undergraduate Admissions, Housing and Dining - http://admissions.caltech.edu/campus-life/housing-dining/

[4] Caltech, Undergraduate Admissions, Campus Life - http://admissions.caltech.edu/campus-life

[5] MIT Facts 2005: Academic Schools and Departments, Divisions & Sections - http://web.mit.edu/facts/academic.shtml

[6] MIT Facts 2005: Enrollment 2005 - http://web.mit.edu/facts/enrollment.shtml

[7] Housing at MIT, Undergraduate Housing - http://web.mit.edu/housing/undergrad/residences.html

In addition to excellent academics, MIT also offers many NCAA Division III intercollegiate sports, and intramural[8]. Over 65 percent of their students do participate. There are also many community student groups and organizations[9].

Princeton University

Princeton is different from Caltech and MIT in that it has many departments other that those for science and engineering. We used information about their School of Engineering and Applied Sciences to design our model. Princeton has a different core curriculum for this school than it does for the other schools[10].

Housing at Princeton is quite unique. Freshmen and sophomores live in residential colleges, which include a cluster of dormitories, a dining hall, lounges, seminar and study rooms, a library, computing facilities, and game and television rooms[11]. Upperclassmen live in individual dormitories.

Princeton offers a wide range of activities for its students. These include many NCAA Division I intercollegiate sports, club and intramural sports, and over 200 student organizations, which include music and student government[12].

Stanford University

Stanford is another large school, which offers a wide range of departments. We focused on their School of Engineering for this project. Stanford has general education requirements for all of its students, and there are also general requirements for the School of Engineering.

Stanford has about 80 residences on campus and houses about 93 percent of its students[13]. Unlike the schools discussed previously, there is no common structure to the residences at Stanford. There is a lot of variation.

---

[8] MIT Facts 2005: Athletics and Recreation - http://web.mit.edu/facts/athletics.shtml
[9] Community Organizations and Student Groups - http://www.mit.edu/life/
[10] Princeton University: Undergraduate Announcement, 2004-05 http://www.princeton.edu/pr/catalog/ua/04/057.htm
[11] Princeton University: Residential Colleges - http://www.princeton.edu/main/campuslife/housingdining/colleges/
[12] Princeton University: Student Organizations - http://www.princeton.edu/main/campuslife/organizations/
[13] Housing Assignment Services, Stanford University: Residence Tour - http://www.stanford.edu/dept/hds/has/tour/index.html

Students at Stanford have the opportunity to participate in an excellent athletic program. Stanford has many NCAA Division I intercollegiate sports teams, as well as recreational sports teams[14]. There are also a lot of programs in the arts, which include music and dance[15].

University of California at Berkeley

Berkeley is a very large university that has many schools. The schools that we were concerned with are the College of Chemistry, the College of Engineering, and the College of Letters and Science. Berkeley has general undergraduate degree requirements that each student must complete, and the individual schools may have their own general requirements[16].

At Berkeley, students live in regular residence halls, as opposed the houses or residential colleges that are found at Caltech, MIT, and Princeton.

Many activities are available for students at Berkeley. The school offers NCAA Division I intercollegiate athletics, clubs, community service groups, arts organizations, and student government organizations[17].

Conclusion

These five schools are examples of first-rate science and engineering schools, and we developed a lot of the academic portions of our model Institute based on information about these schools' academic programs. We used which departments these schools have to determine which departments our model would have. We also used their core curriculums to determine the freshmen curriculum at our model Institute.

Women's Schools

Because our model is for a women's school, we wanted to use information about other women's schools to help design the campus. For this we choose to examine the "Seven Sister" schools.

---

[14] Stanford University: Athletics - http://www.stanford.edu/home/athletics/
[15] Stanford University: Arts and Events - http://www.stanford.edu/home/arts/
[16] University of California, Berkeley: General Catalog - http://www.berkeley.edu/catalog/undergrad/requirements.html
[17] University of California, Berkeley: Activities & Recreation - http://www.berkeley.edu/students/activities/

According to Njeri Brown, in the article "Elite Women's Colleges – The Seven Sisters: Why Choose a Women's College?" these schools are the most prestigious women's liberal arts colleges in the country[18]. They are Barnard College, Bryn Mawr College, Mount Holyoke College, Radcliffe College, Smith College, Vassar College, and Wellesley College. These schools provided excellent education to women when the Ivy League was restricted to male students. Radcliffe and Vassar eventually became coeducational, and recently Radcliffe closed, leaving only five of the original "Seven Sisters".

Although Ivy League schools now accept female students, Brown believes that women's schools are still important. Studies have shown that women at single-sex schools have more self-confidence, choose more masculine areas of study, and pursue doctorate degrees in these areas more extensively than do women at coeducational schools. Therefore, we believe that our model for a women's engineering school would be successful. We designed our model on information about each of the "Seven Sister" colleges, so we will now briefly discuss each one.

Barnard College

Barnard is a women's college next to Columbia University in New York. It was Columbia's sister school when Columbia only accepted male students. It was founded in 1889. "It was governed by its own trustees, faculty, and dean, and was responsible for its own endowment and facilities, while sharing instruction, the library, and the degree of [Columbia]"[19]. It is a small school, with about 296 faculty members, and 2,297 undergraduate students. Although this school was used to help develop our model, it is a liberal arts school, and all of its students receive Bachelor of the Arts degrees.

Bryn Mawr College

Bryn Mawr is a very small women's college located outside Philadelphia. It has about 127 faculty members, 1,334 undergraduates, 447 and graduate students[20]. This school is also a

[18] Elite Women's Colleges - The Seven Sisters: Why Choose a Women's College? - http://www.suite101.com/article.cfm/elite_womens_colleges/68301
[19] Barnard, About the College: Barnard Facts - http://www.barnard.edu/about/facts.html
[20] Bryn Mawr: Bryn Mawr at a Glance - http://www.brynmawr.edu/admissions/at_a_glance.shtml

liberal arts school, and the most popular majors are Political Science and English. Bryn Mawr is one the few small liberal arts schools with a strong graduate program. Its graduate school is however, coeducational.

Mount Holyoke College

Mount Holyoke was founded in 1837 in South Hadley, Massachusetts. "[It] was the first of the Seven Sister schools, and the first institution of higher education for women in the U.S."[21]. It is another small liberal arts school. It has about 2,100 students and a 9:1 student to faculty ratio, which translates to about 233 faculty members.

Radcliffe College

Radcliffe College was created in 1893 in Cambridge, Massachusetts because women could not attend Harvard University. "In the 1970s, the two schools merged and women were officially granted Harvard degrees"[21]. Radcliffe is now a graduate school at Harvard.

Smith College

Smith, which came to be in 1871[22], is a liberal arts college that continues to admit women only. It is located in Northampton, Massachusetts[21]. Smith is the largest women's liberal arts college in the country[22]. There are 285 faculty members and about 2,500 undergraduate students[23]. Although it is now possible for women to attend most colleges, including the Ivy League schools, people at Smith believe that women's colleges are still necessary, and Smith will not convert to a coeducational school.

Vassar College

Vassar, located in Poughkeepsie, New York, was the first "Seven Sister" college to become coeducational. This happened in 1969[21]. Vassar was founded in 1861, and it continues to be one of the highest ranked liberal arts schools in the country[24]. Vassar is one of the larger

[21] What colleges make up the "Seven Sisters"? How did this nickname come about? - http://ask.yahoo.com/ask/20020108.html
[22] Smith College: About Smith - http://www.smith.edu/aboutsmith.php
[23] Smith College: Just the Facts - http://www.smith.edu/about_justthefacts.php
[24] Quick Vassar Facts - http://admissions.vassar.edu/about.html

"Seven Sister" schools, with about 250 faculty members and about 2,400 undergraduate students.

Wellesley College

"Wellesley is a college for the student who has high personal, intellectual, and professional expectations"[25]. The school was founded in 1870 in Wellesley, Massachusetts[26]. It is a school for undergraduate women only. There is no graduate program. There are about 2,400 students, and the student to faculty ratio is about 9:1. This ratio appears to be common to all of the "Seven Sister" schools, and it corresponds to Wellesley having about 267 faculty members.

Conclusion

The "Seven Sister" colleges were founded at a time when women had very few options for higher education. They could not attend IVY League schools, and these top quality institutions provide women a chance to obtain an excellent education. The schools are all small liberal arts schools, but we used information about their campuses, and not their academics, to design our model. Although two of the schools have become coeducational, the other five have stuck with their original mission: to provide a quality education and opportunity to women.

Conclusion

In developing our model for a science and engineering institution for women, it was important to have information about other science and engineering schools, as well as other women's schools. To do this, we researched the top five science and engineering schools and the five remaining "Seven Sister" schools. In the next section we will introduce our model Institute. We will discuss the academics for the Institute first.

[25] Wellesley College: The College - http://www.wellesley.edu/Welcome/college.html
[26] Wellesley College Office for Public Information - http://www.wellesley.edu/PublicAffairs/Media/facts.html

Section III: Academics

In this section, we will discuss the academic portion of our model. Academics includes which departments will be used, what size each department will be, and what the basic core curriculum will be for first year students. We initially determined which departments would be included in our model by looking at the departments at five of the top science and engineering schools in the country. These schools are the California Institute of Technology, the Massachusetts Institute of Technology, Princeton University, Stanford University, and the University of California at Berkeley. Departments that were found at most of these schools were included in the model.

Once we determined which departments to include, we determined their sizes. We used the National Survey of Graduate Faculty to determine the top ten schools in the country for each department. We then found the number of full-time faculty members in each of those departments, and used the smallest one for our model. These numbers were our initial estimate. We then used a survey done by the National Science Foundation to determine the number of women who are interested in each field in our model. We then shrank some departments so that the institute would only need to attract one percent or less of the total number of women who get degrees in each field. After this reanalysis was completed, some of the departments were very small, and were therefore combined with other departments.

Based on the core curriculum of the five top science and engineering schools in the country, we determined the core curriculum for our model. One reason that this curriculum was helpful is that it helped us determine the number of Humanities and Social Science faculty members, and the number of lecture halls that would be required. We will now discuss how we determined the departments, department sizes, and the core curriculum for our model.

Departments at the Model Institute

In the process of developing a new school from the ground up, a very important characteristic of the school that must be determined is the departments that the school will have. The goal is for the proposed school to be first-rate, so it is important to determine what departments are necessary for a school to be first rate. We determined this by examining the departments at five of the top engineering schools in the country. These are California Institute of Technology, Massachusetts Institute of Technology, Princeton University, Stanford University, and the University of California, Berkeley. A complete list of departments found at these schools can be found in Appendix A.

Here is a discussion of the departments found at these top engineering schools, as well as which departments will be found at the model Institute. The section begins with departments that are common to all five of the example schools, then proceeds to the departments found at four of the example schools, and so on. Within these groups, the departments are ordered alphabetically. UC Berkeley, being a very large university, has many departments that were not found at the other example schools. There are many different Humanities and Social Science departments as well as Medical School departments. These extraneous departments will not be discussed.

The departments found at all five of successful science and engineering schools examined are: Biology, Chemical Engineering, Chemistry, Civil and Environmental Engineering, Earth and Planetary Sciences/ Geological Sciences, Electrical Engineering, Mathematics, Mechanical Engineering, and Physics. These departments are obviously a necessary part of a first-rate institution, and therefore, the model Institute will have all of them. Each of these departments will now be considered.

Although each of the successful schools houses at least one Biology department, only four of them have a general Biology department. CalTech has three Biology departments: Biology, Biochemistry and Molecular Biophysics, and Computation and Neural Systems. MIT has a department for Brain and Cognitive Sciences. Princeton, which does not have a general Biology department, has both a Molecular Biology department and an Ecology and Evolutionary Biology department. UC Berkeley, being a very large university, has a general Biology department as well as many other departments in more specific fields of Biology. It is obviously important for the model Institute to have at least a general Biology department. Each of the more specific Biology departments are only found at one or two schools, so none of them must be necessary for a school to be first-rate. Therefore, the model Institute will only have one Biology department.

Chemical Engineering is one of the few departments that does not show variation from school to school. Every example school has one, none of the example schools have more than one, and they all have the same title. The model Institute will have a Chemical Engineering department.

Chemistry is another department that shows no variation. Only UC Berkeley has more than one department. Aside from the Chemistry department, it also has an Agricultural and Environmental Chemistry department. The model Institute will resemble the other successful schools in that it will have one Chemistry department.

Civil and Environmental Engineering shows a lot of variation from school to school. Some schools combine Civil Engineering with Environmental Engineering, while others do not. CalTech has two departments, one for Civil Engineering and one for Environmental Science and Engineering. MIT has a Civil and Environmental Engineering department as well as an Urban Studies and Planning department. Princeton and Stanford have one Civil and Environmental Engineering department. UC Berkeley has a City and Regional Planning department, a Civil and Environmental Engineering department, an Environmental Sciences department, and an Urban Design department. Because all five sample schools have a department for Civil Engineering and a department for Environmental Engineering, and four of them combine them into one department, both fields must be necessary, but having two separate departments must not be. The model Institute will have one Civil and Environmental Engineering department.

In the field of Earth and Planetary Sciences/ Geological Sciences, there is some variation from school to school. CalTech has a department called Earth and Planetary Sciences. MIT has a department for Earth, Atmospheric, and Planetary Sciences. Princeton has a Geosciences department. Stanford has three departments: Geological and Environmental Sciences, Geophysics, and Petroleum Engineering. UC Berkeley has two departments. It has an Earth and Planetary Science department, and also a Mineral Engineering department. The model Institute will call its department Earth and Planetary Sciences. Only two of the example schools have more than one Earth Science department, so more than one must not be necessary for a school to be first rate. Therefore, the model Institute will only have one department for geosciences.

Electrical Engineering departments are sometimes found combined with Computer Science departments. CalTech, Princeton, and Stanford have individual departments for the two. MIT and UC Berkeley have a department of Electrical Engineering and Computer Science. UC Berkeley also has a separate Computer Science department. Because four of the example schools have two departments, the model Institute will have an Electrical Engineering department separate from Computer Science.

Mathematics is another department that shows very little variation within the example schools. All five schools have one general Mathematics department. Some of them have a second department. CalTech has an Applied and Computational Mathematics department. Stanford and UC Berkeley have a Statistics department. Three of the successful schools examined have a second Mathematics department, and only two have the same second department. It must not be necessary for a first-rate Institution to have a second mathematics department. Therefore, the model Institute will have only one.

Every example school has a Mechanical Engineering department, and most have a second, related department. CalTech has an Aeronautics department and a Control and Dynamic Systems department. At MIT and UC Berkeley there is a Nuclear Science and Engineering or Nuclear Science department. MIT and Stanford have an Aeronautics and Astronautics department. Princeton has one department for Mechanical and Aerospace Engineering. Because four of the five sample schools have an Aeronautics department or an Aeronautics and Astronautics department, and three of them separate this department from Mechanical Engineering, the model Institute will have a Mechanical Engineering department and a separate for Aeronautics and Astronautics department.

A general Physics department is found at every example school, and some have a second or third department. CalTech has two extra Physics departments: Applied Mechanics and Applied Physics. Princeton has a department for Astrophysical Sciences. Stanford has an Applied Physics department. UC Berkeley has Biophysics. Although four of the five example schools have a second Physics department, none of the extra departments are found at more than two schools. Therefore, none of them must be necessary, so the model Institute will have a single Physics department.

We now consider departments found at four of the five of the successful schools that were examined. These are: Bioengineering, Computer Science, Management, and Materials Science and Engineering. Although these departments are only found in four of the five example schools, they are probably an important part of a first-rate institution, so the model Institute will have all of them. Here is a more detailed discussion of each of these departments.

Bioengineering is a relatively new field, but it is already found at every successful school except for Princeton. MIT does not have a department for it, but it has a Division. There are faculty members and courses, but no majors. None of the schools have more than one department in this field, so it must not be important to have more than one. The model Institute will have a single Bioengineering department.

All five of the example schools have Computer Science, but only four have a separate department for it. MIT combines Computer Science with Electrical Engineering. UC Berkeley has an Electrical Engineering and Computer Science department, but it also has a separate Computer Science department. Because four of the five example schools have a separate Computer Science department, the model Institute will, too.

A Materials Science department is found at CalTech. MIT, Stanford, and UC Berkeley have Materials Science and Engineering departments. Princeton does not have a department in this field. The department at the model Institute will be Materials Science and Engineering.

CalTech does not have a Business or Management department, but all of the other example schools do. MIT has the Sloan School of Management. Princeton has a department of Operations Research & Financial Engineering. Stanford has a Management Science and Engineering department. UC Berkeley, the only school with a Business department, has Business Administration and Information Management and Systems. Management is more common than Business, so the model Institute will have a Management department.

The only department found at three of the five example schools was Architecture. MIT and UC Berkeley have an Architecture department. Princeton has the school of Architecture. This department is not found at CalTech or Stanford. Therefore, it must not be necessary for an Institute to be first-rate. There will not be an Architecture department at the model Institute.

Only two of the example schools have an Astronomy department. However, Astronomy departments are very common among women's schools. Therefore, the model Institute will have an Astronomy department.

Another important department that the model Institute will have is a Physical Education department. It is important for students to develop their body and mind. All of the example schools have a Physical Education requirement, and the model Institute will as well.

Each of the five sample schools has one or more Humanities departments. CalTech has a Humanities and Social Sciences Division. MIT has a Humanities department with six sub-departments: Anthropology, Foreign Languages and Literatures, History, Literature, Music and Theater Arts, and Writing and Humanistic Studies. MIT also has a Linguistics and Philosophy department. Princeton has many Humanities departments. These include Anthropology, Art and Archaeology, Comparative Literature, English, History, Music, several departments for foreign languages, and several departments for studies of different cultures. Stanford also has many different Humanities departments. These include two Anthropology departments, Art and Art

History, Communication, Comparative Literature, Drama, English, History, Linguistics, Music, several departments for foreign languages and several departments for studies of different cultures. UC Berkeley has too many Humanities departments to name. Almost all of the departments found at the other example schools are found at Berkeley.

The example schools show many different departments in the Social Sciences. Many of the departments are found at several schools. CalTech only has one department, and it is for Humanities and Social Sciences. MIT has two departments: Economics and Political Science. Princeton has many Social Science departments. These are Economics, Philosophy, Politics, Psychology, Sociology, and the Woodrow Wilson School of Public and International Affairs. Stanford has similar departments: Economics, Philosophy, Political Science, Psychology, and Sociology. UC Berkeley has many of the same Social Science departments as the other example schools as well as several more.

The model Institute will only have one Humanities and Social Sciences department. Humanities professors in this department will specialize in several different fields such as: Anthropology, English, Foreign Cultures, Foreign Languages, History, Linguistics, Literature, Music, and Writing. There will be Social Science professors that specialize in: Economics, Philosophy, Political Science, Psychology, and Sociology.

The result of this section is a preliminary list of departments at the model Institute. In the next section, we determine the size of each department and ask whether or not it would be feasible to have all of these departments. As a result, some of the departments were combined with other departments.

Department Sizes

Introduction

The first step in determining how large the departments at the model institute need to be was to look at the sizes of successful departments at other schools. Using the National Survey of Graduate Faculty[1], a list of the top ten ranked departments for each field was developed, and the number of full-time faculty members at each was determined. From there, some of the smallest departments for each field were researched, and information was gathered on the number of undergraduate and graduate students each one had. These numbers do not include the number of freshmen, because students do not generally pick a major until sophomore year. Based on this information, estimates for the sizes of the departments at the model Institute were determined. The goal was to create departments that would be as small as possible, yet be ranked in the top ten nationally. A large effort will be needed to recruit top professors to fill positions at the model institute. Our intent is for the departments at the model Institute to be ranked in the top ten.

Once these sizes were determined, we checked to make sure they were possible. We did not want our model to include outrageous assumptions such as expecting every woman who studies Electrical Engineering will attend our Institution. To assure that our model was feasible, we used a study done by the National Science Foundation. This foundation produces a series of tables of Science and Engineering degrees awarded in 1966 – 2001. These tables show degrees earned by gender. They may be found in Appendix B. We used these tables to ensure that our model only assumed that less than one percent of women who receive degrees in each field will receive their degree from our model Institute.

Aeronautics & Astronautics

Of the schools that have Aeronautics and Astronautics departments that rank in the top ten, three of them combine their department with Mechanical Engineering. Of the other seven, only one had available numbers for both undergraduate students and graduate students. This school is the Georgia Institute of Technology, which is ranked ninth. The two smallest departments are Caltech, ranked first, and the University of Michigan, ranked fifth. Caltech has 12 full-time faculty members and 54 graduate

[1] Goldberger, Marvin L.; Maher, Brendan A.; Flattau, Pamela Ebert. Research-Doctorate Programs in the United States: Continuity and Change. National Academy Press, Washington, D.C. 1995. Copyright 1995.

students. Michigan has 21 full-time faculty members and 156 graduate students. The model Institute will have 12 full-time faculty members, because this is the number Caltech uses, and Caltech's department is very successful. Georgia Tech has about the same number of graduate students as undergraduates. Using that ratio as well as the number of graduate students at Caltech, it was determined that the model Institute's Aeronautics and Astronautics department will consist of 50 – 55 graduate students and 50 – 55 undergraduates.

Astronomy

Astronomy was the first scientific field in which women became prominent, so it is important that the model institute have an Astronomy department. The size of the department was determined by examining the sizes of the departments at each of the Seven Sister colleges. The "Seven Sisters" are schools that were created for women in a time when they could not attend men's schools such as Harvard. Radcliffe College, the sister school of Harvard University, and Smith College have rather large Astronomy departments. The other five schools have good departments with considerably fewer faculty members. The average faculty size at these schools is 4. This is a very small faculty, and such a department would probably not be stable. Therefore, the model department will use 10 full-time faculty members. This proposed department will include have 25 – 30 undergraduates. There will also be an astronomy graduate program, but not when the school first opens.

Biology

In the National Survey of Graduate Faculty, Biology departments are not ranked as general Biology. They are ranked in different fields of Biology. The model Institute will only have one Biology department. This Biology department will be designed from information about departments of five of the top science schools in the country. These schools are the California Institute of Technology, Massachusetts Institute of Technology, Princeton University, Stanford University, and the University of California at Berkeley. Caltech has 38 full-time faculty members, 100 graduate students, and 100 undergraduates in the Biology department. MIT's department contains 55 full-time faculty, but the number of students was not available. Princeton does not have a general Biology department, so information was found for the molecular Biology department. It has 51 full-time faculty, 120 graduate students, and 100 undergraduate students. Stanford's general Biology department contains 49 full-time faculty, 110 graduate students, and the number of undergraduates could not be found. UC Berkeley is another school that does not have a general Biology department. The smallest number of faculty in these departments is 38, so that is the number the model Institute will use. Information about the number of students was only found for Caltech and Princeton. Both schools have 100 undergraduates, and a similar number of graduate students. There is information about the number of graduate students for three schools, and all three are similar. The average number is 110. The model Institute will have 95 – 100 undergraduate students and 105 – 115 graduate students.

Bioengineering/ Biomedical Engineering

The University of California, San Francisco has the smallest Biomedical Engineering department in the top ten. It is currently ranked seventh. There are 14 full-time faculty members, but data was not available on the number of undergraduate and graduate students. Ranked ninth, the University of Utah has the second smallest department with 17 full-time faculty members. There are 67 full-time graduate students, but again, the number of undergraduates was not available. University of California, San Diego is ranked second and has the third smallest department. There are 18 full-time faculty, 500 undergraduates, and 96 full-time graduate students. This department is an anomaly. There is a very large number of undergraduate students for the number of faculty members. The fourth smallest department belongs to the University of Washington. This department is ranked third, with 20 full-time faculty, 97 undergraduates, and 97 graduate students. The model Bioengineering department will be designed based upon these four departments, and will include 15 full-time faculty members, because UCSF has a very successful department with only 14 members. The number of students was determined by looking at the ratios demonstrated by the University of Washington. We determined the model Institute's department to be 75 – 80 undergraduates, and 75 – 80 graduate students.

Chemical Engineering

The two smallest Chemical Engineering departments in the top ten are that of the California Institute of Technology, ranked sixth, and Stanford University, ranked seventh. Both schools have 11 full-time faculty, but data was unavailable on the number of undergraduate or graduate students in either department. However, in 2003, Caltech awarded 20 Bachelor's degrees. If we assume that each class contains the same number of students, Caltech's department would consist of about 60 undergraduates. Stanford awarded 68 Bachelor's degrees. Using the same logic, this department would have 204 undergraduates. The third smallest department in the top ten is that of the University of Illinois at Urbana-Champaign, ranked fifth. This department consists of 20 full-time faculty, over 300 undergraduates, and 103 graduate students. Using this information, the size of the model school's chemical engineering department was determined. There will be 11 full-time faculty members, because both Caltech and Stanford have remained in the top ten with a faculty of this size. Using Caltech's student faculty ratio of 8:1, the number of students in the proposed department was determined. There will be 65 – 70 undergraduates and 20 – 25 graduate students.

Chemistry

The size of the model Chemistry department was determined from information about Harvard University's department, tied for third, and Columbia University's department, ranked seventh. Harvard has the smallest department in the top ten. It consists of 22 faculty, 140 undergraduates, and 208 graduate students. Columbia's department is very similar. The number of undergraduates was unavailable, but there are 23 faculty and 200 graduate students. Harvard's department is small and successful, so the model Institute's department was modeled after it. We determined that the model Institute could have a chemistry department among the top ten in the country with 22 full-time faculty members, 140 – 145 undergraduates and 205 – 210 graduate students.

Civil & Environmental Engineering

In the field of Civil Engineering, Stanford University is ranked third and Princeton University eighth. The California Institute of Technology had the smallest department in the top ten, but information was not available on the number of undergraduate students. Therefore, the model institute's Civil Engineering department will be designed based on information about Stanford and Princeton. Stanford has 27 full-time faculty for 47 undergraduates and 235 graduate students. Princeton is smaller, with 13 full-time faculty for 57 undergraduates and 43 graduate students. Cal Tech has 5 full-time faculty, for 14 graduate students. From this data, it was determined that the model institute can have a successful top ten Civil Engineering department with only 13 full-time faculty members. This number of faculty is capable of supporting 57 undergraduates and 43 graduate students at Princeton, and therefore will be capable of supporting the same numbers at any school with a strong faculty. The proposed Civil Engineering department will aim to have about 50 - 60 undergraduate students, and 40 – 45 graduate students.

Computer Science

The three smallest Computer Science departments that rank in the top ten are Princeton University, ranked sixth, the University of Wisconsin Madison, ranked ninth, and the University of Washington, ranked tenth. Princeton's department is made up of 32 full-time faculty members, 140 undergraduates, and 102 graduate students. The University of Wisconsin has 43 full-time faculty members, 194 undergraduates, and 432 graduate students. The University of Washington is the largest of the three, with 44 full-time faculty, 450 undergraduates, and 275 graduate students. Princeton has a very successful department and it is the smallest of the top ten. The proposed department is to be as small as possible, but still remain in the top ten. Therefore, the department will be modeled after Princeton's. There will be 32 full-time faculty members, 135 – 140 undergraduates, and 100 – 105 graduate students.

Earth & Planetary Sciences

The three schools ranked in the top ten for Earth and Planetary Science, that have the smallest departments, are the University of Chicago, Stanford University, and Cornell University. These departments are ranked seventh, ninth, and tenth, respectively. Because all three departments have 23 full-time faculty members, this number must be sufficient for an Earth and Planetary Science department to be ranked in the top ten. Chicago's department contains 35 graduate students, but the number of undergraduates was unavailable. The department at Stanford has 113 undergraduates and 6 graduate students. There was no available information about the numbers of undergraduate or graduate students in the department at Cornell. Because Stanford's department seems to have a large number of undergraduates and a small number of graduate students for the number of faculty, we also examined the departments at Harvard University and the California Institute of Technology. Harvard's department is ranked eighth. It has 25 full-time faculty members, 25 undergraduates, and 53 graduate students. Caltech's department is ranked first. This department has 35 full-time faculty members, 28 undergraduates, and 88 graduate students. These numbers are more reasonable than Stanford's. From this information, the department at the model Institute was designed. It will have 23 faculty members, 20 – 25 undergraduate students, and 50 – 55 graduate students.

Electrical Engineering

The four smallest Electrical Engineering departments that are ranked in the top ten are California Institute of Technology, (fifth), Princeton University (ninth), University of California Berkeley (fourth), and Cornell University (seventh). Caltech has 24 full-time faculty members and 95 graduate students. There was no information about the number of undergraduates. Princeton has 32 full-time faculty members, 98 undergraduates and 216 graduate students. UC Berkeley is larger with 51 full-time faculty, but there was no information about the number of students. Cornell is the largest. It has 53 full-time faculty members, over 500 undergraduates and 300 graduate students. Princeton's Electrical Engineering department uses a 8 to 1 all students to faculty ratio and the 2 to 1 graduate student to undergraduate ratio. When these ratios were applied to 24 full-time faculty members, which appears to be the lowest number this type of department can have and still be successful, the model department's size was determined. There will be 24 full-time faculty members, 60 – 65 undergraduates and 125 – 130 graduate students.

Humanities & Social Sciences

In the curriculum section, it was determined that there will be a Humanities and Social Sciences requirement that must be completed by all students. This requirement was determined to be eight courses. Students will take about one course per semester. Each class will be made up of about 25 students and each Humanities or Social Science Professor will teach three courses every two semesters. Therefore, the model Institute will need about 30 Humanities and Social Science Professors.

Management

After determining the top ten departments in each field of engineering, it appears that the top five engineering schools are MIT, Princeton, Stanford, Caltech, and UC Berkeley. Of these schools, Caltech is the only one without a Management or Business department. MIT's Sloan School of

Management has 96 full-time professors and over 1,100 total students. Princeton's management department has 13 full-time faculty members, but the number of students was unavailable. Stanford's department has 39 full-time faculty members, 126 undergraduates and 402 graduate students. Berkeley only has a graduate program. It has 14 faculty members. There are 40 masters' students per class and 15 doctorate students. Using the student to faculty ratio of Stanford with Princeton's number of faculty, we determined the size of the management department at the model Institute. There will be 13 faculty members, 40 – 45 undergraduates, and 130 – 135 graduate students.

Materials Science & Engineering

In the field of Material Science and Engineering, the smallest departments in the top ten are those of Stanford University, ranked sixth; Cornell University, ranked third; and the University of Pennsylvania, ranked tenth. Stanford's program has only 13 full-time faculty members, and the number of students was not available. Cornell has 15 full-time faculty members, and 43 graduate students. The number of undergraduates was unavailable. Penn also has 15 full-time faculty members, but it has 50 graduate students, and 35 undergraduates. These departments are very similar in size. The model Institute's department was based on the size of the department at the University of Pennsylvania. The Materials Science and Engineering department will consist of 15 full-time faculty members, 45 – 50 graduate students, and 30 – 35 undergraduate students.

Mathematics

The smallest Mathematics departments that rank in the top ten are those of Harvard University, ranked fourth, and Yale University, ranked seventh. Harvard has 24 full-time faculty and 102 graduate students, while Yale has 29 full-time faculty and 40 graduate students. The smallest top ten school that had undergraduate information was Princeton University. It is the fifth smallest department and it is tied for first in the rankings. This department includes 52 full-time faculty, 30 undergraduates and 55 graduate students. The undergraduates are only juniors and seniors. The University of California Berkeley has one of the largest departments in the top ten, but we gathered data about their program because it is tied for first in the rankings and it was one of the only department for which the number of undergraduates could be found. This department has 69 full-time faculty, 600 undergraduates and 180 graduate students. This is an 11 to 1 all students to faculty ratio. The model department will be as small as it can to be ranked in the top ten. Therefore, there will be 24 full-time faculty members. Princeton, tied for first, demonstrates a 2:1 all students faculty ratio, and about a 1.2:1 graduate student to undergraduate ratio. Averaging these ratios with those of Berkeley, also tied for first, we found a 6.5:1 all students to faculty ratio and a 2:1 undergraduate to graduate ratio. Using these ratios, the model department will have 100 – 105 undergraduates and 50 – 55 graduate students.

Mechanical Engineering

The California Institute of Technology, ranked fourth, has the smallest Mechanical Engineering department of the top ten. It consists of 15 full-time faculty, 80 undergraduates, and 61 graduate students. The second smallest department is that of Princeton University, ranked sixth, with 24 full-time faculty. There are 1000 undergraduates and 120 graduate students combined between mechanical engineering, aerospace engineering, and chemical engineering. Stanford University, having 32 full-time Mechanical Engineering faculty, is the third smallest department. It is ranked first. No information could be found on the number of students. The fourth smallest department in the top ten belongs to Cornell University, ranked seventh. This department has 37 full-time faculty members and 132 graduate students. There was no information available about the number of undergraduate students. Caltech's department is very successful and also very small. The proposed Mechanical Engineering department will be modeled after it. There will be 15 full-time faculty, 80 – 85 undergraduates, and 60 – 65 graduate students.

Physics

Stanford University, Princeton University, and Harvard University, the three smallest schools in the top ten, are ranked ninth, second, and first respectively for physics. Stanford has 33 full-time faculty members and 115 graduate students. Information was not available on the number of undergraduate students in the department. Princeton is larger, with 40 full-time faculty members. However, there are only 48 undergraduates and 95 graduate students. Harvard, the largest of the three, has 41 faculty members, 111 undergraduates and 147 graduate students. Princeton and Harvard's departments are much more successful than Stanford's, so the model department will be based on them. It can be ranked in the top ten with 33 full-time faculty members, 100 – 110 undergraduates and 140 – 145 graduate students.

The Freshmen Class

The numbers of undergraduates in the different departments were the numbers of sophomores, juniors and seniors. These numbers did not include freshmen because students do not declare a major until sophomore year. Therefore, the size of the freshmen class at the model Institute had to be determined separately. It was calculated by taking the total number of sophomores, juniors and seniors, and dividing that number by 3. This is the average number of students per year. This number was then increased by about 20 students to make up for a less than perfect retention rate. The incoming freshmen class will average about 400 students.

Table 1. Initial Department Sizes at the model Institute

Department	Number of full-time faculty	Number of Undergraduates	Number of Graduate Students
Aeronautics & Astronautics	12	50 – 55	50 – 55
Astronomy	10	25 – 30	N / A
Biology	38	95 – 100	105 – 115
Bioengineering/ Biomedical Engineering	15	75 – 80	75 – 80
Chemical Engineering	11	65 – 70	20 – 25
Chemistry	22	140 – 145	205 – 210
Civil & Environmental Engineering	13	50 – 60	40 – 45
Computer Science	32	135 – 140	100 – 105
Earth & Planetary Sciences	23	20 – 25	50 – 55
Electrical Engineering	24	60 – 65	125 – 130
Humanities & Social Sciences	30	N/A	N/A
Management	13	40 – 45	130 – 135
Materials Science & Engineering	15	30 – 35	45 – 50
Mathematics	24	100 – 105	50 – 55
Mechanical Engineering	15	80 – 85	60 – 65
Physics	33	100 – 110	140 – 145
Freshmen	N/A	400	N/A
Total	330	1085 – 1160	1195 – 1265

This table shows the numbers or faculty, undergraduates, and graduate students that the model Institute would have if department sizes were based solely upon the sizes of the smallest departments that rank in the top ten in the country.

Is there a market for this school?

The numbers in the table above are the numbers that were determined by examining the smallest departments that are currently ranked in the top ten in the country. These numbers may not be suitable for a small women's school. Below is a table that lists the number of Bachelor degrees awarded to women in each field in 2001[2]. These numbers were found in tables produced by the National Science Foundation. These tables are shown in Appendix B. From these numbers, we revised the number of undergraduate students in each department at the model Institute so that only one percent of women receiving degrees in each field would receive their degree from our institution. We then used these numbers to revise the numbers of faculty members and graduate students in each department. The results of these calculations are shown in Table 3.

Table 2. Number of Bachelor's Degrees awarded to Women in 2001 by Field

Department	Original Number of full-time faculty	Number of Degrees to Women in 2001
Aeronautics & Astronautics	12	304
Astronomy	10	95
Biology	38	37,084
Bioengineering/ Biomedical Engineering	15	Not available
Chemical Engineering	11	2,055
Chemistry	22	4,775
Civil & Environmental Engineering	13	2,041 (just civil)
Computer Science	32	11,900
Earth & Planetary Sciences	23	1,622
Electrical Engineering	24	2,542
Materials Science & Engineering	15	263
Mathematics	24	5,497
Mechanical Engineering	15	1,739
Physics	33	756
Total		70,653

This table gives the number of degrees awarded to women in specific fields of science and engineering. This data was taken from a study done by the National Science Foundation[3].

We will first discuss the engineering fields, in order of decreasing number of degrees awarded to women. In these fields, the preliminary faculty numbers show that the average number of faculty is 15.

As shown in table 2, there are more women receiving degrees in Electrical Engineering than there are in the other fields, but the number of women in Electrical Engineering is only about 25% larger than those of Chemical and Civil Engineering, which have the next largest number of degrees. Therefore, the Electrical Engineering department at the model Institute will be the largest of the engineering

[2] National Science Foundation: Science and Engineering Degrees - http://www.nsf.gov/statistics/pubseri.cfm?TopID=2&SubID=5&SeriID=10
[3] Detailed Statistical Tables - http://www.nsf.gov/sbe/srs/nsf04311/sectb.htm

departments. Electrical Engineering at the model Institute has 24 faculty members, which is far above the average number of faculty members per department at the Institute. The number of Electrical Engineering faculty members will be reduced to 19.

Table 2 shows that Chemical Engineering has the second largest number of degrees awarded to women each year. After the preliminary calculations, the number of faculty members in this department was below the average number of faculty members per department at the model Institute. It is concluded that the number of faculty members in the Chemical Engineering department should be increased slightly. The revised number of faculty members in this department will be 15.

Nationally, the number of women receiving degrees in Civil Engineering is about the same as the number in Chemical Engineering. Therefore, the department of Civil and Environment Engineering at the model Institute should have about the same numbers of faculty members and students as the department of Chemical Engineering.

Mechanical Engineering is the engineering field that has the fourth largest number of degrees awarded to women (Table 2). This number of degrees is not significantly fewer than that of Chemical Engineering or Civil Engineering. Therefore, the numbers of faculty and students in the Mechanical Engineering department at the model Institute will be the same as the departments of Chemical Engineering or Civil Engineering.

According to Table 2, the number of Aeronautics and Astronautics degrees awarded to women is much lower than the previously discussed engineering departments. The number of women who received degrees in this field in 2001 is 304, which is only 1/8 that of Electrical Engineering. It is not necessary for this department to be as large as the others, but it will require enough faculty members to be a strong department. I estimate that it will have 12 faculty members.

Although the number of degrees awarded to women in Materials Science and Engineering is smaller than that of Aeronautics and Astronautics, the numbers are about equal when compared to the other engineering fields. Therefore, these two departments at the model Institute will both have 12 faculty members.

The field of Bioengineering is relatively new, and there was no data available for the number of women who receive degrees each year. Therefore, this department will remain at the average number of faculty per department at the model Institute.

We will now discuss the science fields in more detail. From the preliminary calculations, the average number of faculty members in these fields was 26. We now treat the number of faculty in each science department in order of decreasing number of degrees awarded to women.

It is obvious from the table above that significantly more women receive degrees in the field of Biology than any other science or engineering field. Biology will be the largest department at the model Institute. Reviewing the preliminary department sizes in table 1, the Biology department already has the largest number of faculty. This number will not be revised.

Computer Science has the second largest number of degrees awarded to women. Excluding Biology, there are many more women receiving degrees in Computer Science than in any other science or engineering field. Therefore, it is reasonable for this department to be one of the largest departments at the model Institute, second only to the Biology department. The number of faculty is left at 32.

According to table 2, the field with the third largest number of degrees awarded to women is that of Mathematics, although there are only half as many degrees awarded in this field as there are in Computer Science. This department could be shrunk based on the number of women who receive degrees in the field. On the other hand, every student at the model Institute will be taking courses in Mathematics. Therefore, this department will need more faculty members than other departments. If students take 3 courses in Mathematics over the course of their freshman and sophomore years, and the same courses are taken by all students, there can be 60 students in each class. Therefore, the number of Mathematics faculty will have to be at least 14. The department will also require professors to teach upper level courses, so the preliminary number of 24 faculty members is reasonable, and will not be revised.

A slightly lower number of women receive degrees in the field of Chemistry than in Mathematics. A large percentage of students at the model Institute will be taking Chemistry courses, regardless of their major. Also, there are many more women receiving degrees in Chemistry than there are in Electrical

Engineering, the largest of the engineering fields. Therefore, the number of faculty for the department of Chemistry at the model Institute should be slightly smaller than that of the Mathematics department, but slightly larger than that of the Electrical Engineering department. The preliminary number of faculty members, 22, is reasonable.

The number of degrees awarded to women in the field of Earth and Planetary science is slightly lower than the average number of degrees awarded in the engineering fields. Therefore, the numbers of students and faculty members in the Earth and Planetary science department at the model Institute will be slightly lower than those departments. It will consist of 14 faculty members.

Physics is a field in which few women receive degrees each year. There are about half as many women receiving degrees in this field than there are in Earth and Planetary Science, and about twice as many as there are in Aeronautics and Astronautics. Therefore, the Physics department will be shrunk from its preliminary size of 33 faculty members. However, many students at the model Institute will be taking Physics courses regardless of their major. Therefore, the department of Physics at the model Institute will have 20 faculty members.

As shown in Table 2, Astronomy is the science field that awards the lowest number of degrees to women each year. Only 95 women received Astronomy degrees in 2001. Therefore, this department will be combined with the Earth and Planetary Sciences department, forming an Earth, Planetary, and Astronomical Sciences department.

We only researched the number of women in science and engineering fields. Therefore, we did not include Management. The model Institute's previously designed Management department was slightly smaller than the revised engineering departments, and its size was based on the management departments of five top engineering schools. We did not feel it was necessary to revise the size of the Management department.

To determine the number of graduate students at the model Institute, we decided to use a ratio of graduate students to faculty members that is typical at successful schools. The sizes of the departments displayed in Table 1 were determined by modeling them after successful departments. As a result, the graduate student to faculty member ratios that arose must be typical of strong departments.

We calculated these ratios for each department and found the average, excluding the departments whose ratios were significantly higher or lower than the majority. We found the average ratio to be slightly higher than 3:1. We decided to use a 3:1 ratio and applied it to the number of faculty members. The computed number of graduate students in each department is shown in Table 3.

We followed the same procedure when determining the number of undergraduates. We calculated this average ratio to be about 3.7:1. We applied this ratio to the number of faculty members in each department to compute the number of undergraduates in each department. We then compared the calculated number of undergraduate students in each department to the number of women receiving degrees in the field each year. The number of undergraduates in Table 3 represents upperclassmen (sophomores, juniors, and seniors), and does not include freshmen. Therefore, we divided these numbers by three to calculate the average number of students that would receive degrees from the model Institute each year. We then divided this number of degrees by the total number of degrees award to women in 2001 in each field. This led to a percentage of women in each field that our model is assuming would attend the Institute. Most of these percentages were less than one percent. It is reasonable to assume that a new school could attract at least one percent of the women interested in science and engineering. Four of the percentages however, exceeded one percent. These are Aeronautics and Astronautics (4%), Materials Science and Engineering (5%), Mechanical Engineering (1.1%), and Physics (3%). We considered shrinking these departments to include less than one percent of the total women entering the field. Unfortunately, less than one percent of women in Aeronautics and Astronautics, and Materials Science and Engineering translates to less than 10 undergraduate students in each department. For this reason, we decided to combine these two departments with the department of Mechanical Engineering. We added 15 undergraduate students and one faculty member to the department of Mechanical Engineering to account for Materials Science and Aeronautics. These additions resulted in a student faculty ratio of 3.75:1 in the Mechanical Engineering department. The final numbers are displayed in Table 3.

Once the revised number of students had been determined, the number of freshmen and the number of faculty members in the Humanities department were recalculated using the same approach that was used during the preliminary calculations. Once we had the total number of undergraduates and the total number of faculty, we determined the student to faculty ratio of the model Institute to be about 4.2:1.

Table 3 Revised Department Sizes at the model Institute

Department	Number of full-time faculty	Number of Undergraduates	Number of Graduate Students
Biology	38	140 – 145	110 – 115
Bioengineering/ Biomedical Engineering	15	55 – 60	45 – 50
Chemical Engineering	15	55 – 60	45 – 50
Chemistry	22	80 – 85	65 – 70
Civil & Environmental Engineering	15	55 – 60	45 – 50
Computer Science	32	115 – 120	95 – 100
Earth, Planetary, and Astronomical Sciences	14	50 – 55	40 – 45
Electrical Engineering	19	70 – 75	55 – 60
Humanities & Social Sciences	31	N/A	N/A
Management	13	45 – 50	35 – 40
Mathematics	24	85 – 90	70 – 75
Mechanical Engineering	16	60 – 65	45 – 50
Physics	20	20 – 25	60 – 65
Freshmen	N/A	300	N/A
Total	274	1130 – 1190	710 – 770

This table shows the numbers or faculty, undergraduates, and graduate students that the model Institute will have after reviewing the number of women in each field.

The total numbers of faculty and students show that the model Institute will be roughly the size of the California Institute of Technology, which has 283 faculty and 2,172 students[4]. Therefore, when determining many other aspects of the model Institute, we may compare our results to Caltech.

In the next section, we will develop the core curriculum for our model based on the core curriculums of the five top science and engineering schools in the country. Later, we will use this curriculum, along with the department sizes and approximate size of the freshmen class, to determine the number and size of the classrooms in the academic building.

---

[4] California Institute of Technology: At a Glance - http://www.caltech.edu/at-a-glance/

Curriculum for First Year Students

The curriculum at the model Institute will be designed mostly by the faculty. However, the number of courses students take each semester, and the courses that will be taken by all freshmen were determined from information about the curricula at the California Institute of Technology, Olin College, Princeton University, and Stanford University. Information about freshman courses was not available for the Massachusetts Institute of Technology or for the University of California at Berkeley.

Table 4. Courses taken by freshmen at various engineering schools

Subject	California Institute of Technology	Olin College	Princeton University	Stanford University
Calculus	1 year	1 year	1 year	2/3 year
Physics	1 year	1 year	1 year	
Humanities	1 year	½ year		1 year
Entrepreneurship		½ year		
Writing			½ year	1/3 year
Chemistry	1 year		½ year	

This table shows the courses that freshmen take at Caltech, Olin, Princeton, and Stanford. Courses taken by freshmen at MIT and UC Berkeley could not be found.

Students at MIT and Princeton wait until sophomore year to choose a major. Students at Caltech choose their major at the end of their freshmen year. These schools are very successful, and their engineering departments rank in the top ten in the country. Also, most students have very little knowledge of engineering when entering college. For these reasons, a student at the model institute will not choose his or her major until their sophomore year and all students will take similar courses in their first year of study. We will now discuss the various subjects that freshmen will take.

Calculus

Each student will take 2 Calculus courses, one each term. This was determined by looking at the amount of Mathematics taken by freshmen at the sample schools. Students at Caltech, Olin and Princeton all take Calculus for the entirety of their freshmen year. Students at Stanford take two courses their freshmen year, but this is only two-thirds of a year because of

Stanford's quarter system. The model Institute will use a semester system, so students will take two calculus courses in their freshmen year.

Physics

Students at Caltech, Olin and Princeton take Physics courses throughout their freshmen year. Most of the students at the model Institute will study science or engineering, where Physics is very important. Therefore, all freshmen will take two Physics courses.

Humanities and Social Sciences

The top five engineering schools in the country appear to be MIT, Stanford, Princeton, Berkeley, and Caltech. Although these schools have very different curricula, they do have some things in common. One of these similarities is a Humanities and Social Sciences Requirement. Below is data collected on the requirements of each of these schools, as well as Olin College. These courses are obviously very important for engineering students to take. Therefore, the model institute will require minimum number of Humanities and Social Science courses to be taken by all students.

Table 5. Humanities and Social Science requirements of engineering schools

School	Humanities Courses	Social Science Courses	Humanities or Social Sciences	Total	Total Hours	Courses per term
California Institute of Technology	4	4	4	12	108	1
Massachusetts Institute of Technology	*	*	12	12	144	1.5
Olin College	*	*	7[1]	7[1]	84	0.75
Princeton University	1	*	7	8	?	1
Stanford University	8	2	*	10	?	0.83
University of California, Berkeley	1	*	5	6	?	0.75
Averages				9.17	112	0.97
The model Institute				8		1

This table shows the humanities and social science requirements of Caltech, MIT, Olin, Princeton, Stanford, Olin, and Berkeley. It also shows the requirements that the model Institute will have.

[1] Students at Olin College are required to take 5 courses in Humanities, Arts, and Social Sciences, and are then must complete a capstone project.

California Institute of Technology

Caltech requires each of its students to complete 36 units of Humanities and 36 units of Social Sciences. Students are also required to complete an additional 36 units worth of Humanities and Social Sciences courses of their choosing. Almost all of these courses are worth 9 units, meaning that they involve 9 hours of work per week including lab and homework time. Therefore students are required to complete 108 hours, 12 courses, of Humanities and Social Sciences. At Caltech, there are 4 quarters per year, but most students take summer quarter off from academics. This means that students average 1 Humanities or Social Science course per term for four years. Writing is an important part of an engineer's education. Almost all Humanities courses at Caltech require at least 4,000 words of composition.

Massachusetts Institute of Technology

MIT has GIR's, or General Institute Requirements. These requirements include 8 subjects in Humanities, Arts and Social Sciences, as well as a communication requirement. The communication requirement is 4 subjects of writing. One subject is 12 units of credit, which is a typical course. These courses require 12 hours of work per week including time spent in the classroom and laboratories, which gives a total of 144 hours for the requirement. MIT has two semesters per academic year, so there are 8 total terms. Therefore, students average 1.5 courses in Humanities, Arts and Social Sciences per term.

Olin College

The Humanities requirement at Olin College is comprised of Arts, Humanities, Social Sciences, and Entrepreneurship courses. This requirement is 28 credits. Students at Olin take 5 courses in the Humanities and Social Sciences, and then complete a capstone project that demonstrates their broad knowledge of the field. Olin students also must take one Humanities and Social Sciences course and one Entrepreneurship course their freshmen year. The remaining 4 courses and capstone project may then be either in the Humanities or Entrepreneurship. Students at Olin College take 3 Humanities or Social Science courses per 4 semesters.

Princeton University

Students at Princeton must complete at least 8 courses in the Humanities and Social Sciences, about 1 course per semester. This includes a 1 semester writing requirement. Also, students must take 7 other Humanities and/or Social Science courses. These must include one course in 4 of the 5 following areas: Epistemology and Cognition, Ethical Thought and Moral Values, Historical Analysis, Literature and the Arts, and Social Analysis. Therefore, students at Princeton gain a background in multiple different areas.

Stanford University

Stanford has 4 quarters however most students take the summer quarter off from studies. All freshmen take a 3-quarter introduction to Humanities sequence, where students are allowed to choose which courses they would like to take. There is also one or two quarter writing requirement depending on high school preparation. Students must take at least 3 more Humanities and Social Science courses as well as 1 year of a foreign language, or 3 courses. There is a total requirement of 10 courses, which means that students average about 0.83 courses per quarter.

University of California, Berkeley

Berkeley requires 6 Humanities and Social Science courses, which includes an American Cultures course. These courses also include one writing course. Two of the courses that students take must be from the same department. Berkeley uses the standard semester system that most schools use. Therefore, there are 8 terms in an average undergraduate's degree program, and students average 3 Humanities or Social Science courses per 4 terms.

The Model Institute Humanities Department

After reviewing the requirements of some of the top engineering schools in the country, it appears that 1 Humanities/Social Science course per term, or equivalent is a standard requirement. The model Institute will use the semester system, so students will take 8 courses in the Humanities and Social Sciences. Of these 8 courses, one will be a scientific writing course. Stanford, MIT, Princeton, Berkeley, Caltech and Olin all have a writing requirement. Most require actual writing courses. At Princeton, most Humanities classes require at least 4,000 words of composition. Writing is a very important part of every student's education. Caltech, Stanford, Princeton, and Berkeley require Social Science courses specifically. Of these, Stanford and Berkeley require their students to take at least one History course. Berkeley requires an American History course. Students at the model institute will be required to take at least two Social Sciences courses, including one American History course. Olin, MIT and Berkeley all require that multiple Humanities courses be taken in the same area. Berkeley requires 2 courses in the same department. MIT's requirement includes 3 or 4 courses in the same field that combine to form a Humanities concentration. Olin requires that its students complete at least 4 courses in the same area, and follow that up with a capstone project. Therefore, the remaining 5 courses that the model Institute requires will consist of 4 courses in the same field and one Humanities/Social Science elective.

Each student is required to take about one Humanities/Social Science class per semester. The average class size of these courses at the model Institute will be 30 students. Each Humanities professor will teach three courses per two semesters. Therefore, the Institute will need 31 Humanities professors.

The required scientific Writing course will be very useful in later courses, so it will be completed in the first year. Therefore, freshmen will take the scientific Writing course and one other Humanities or Social Science course of their choosing.

Chemistry

Chemistry is also an important subject. It is useful in all scientific and engineering fields. Therefore, every freshman at the model Institute will take one course in Chemistry.

Engineering

For engineering students, this first year will include a course called Introduction to Engineering. The material taught in this course will be the basic concepts of engineering that apply to all disciplines. Students will also gain useful knowledge about each of the disciplines. They will be introduced to some of the more elementary concepts of each field and learn about what type of career opportunities are available for each major. The intention of this course is to provide students with the proper engineering background needed to choose the major that is right for them.

Other Courses

Students will also take one other science course and an elective of their choosing. If a student has already decided which major she would like to pursue, she may choose to use this elective to start taking courses in that major.

Conclusion

Our model Institute is going to be a first-rate school. Therefore, the core curriculum found at our institution should be similar to those of other first-rate schools. We developed our core curriculum from information about Caltech, MIT, Princeton, Stanford, and UC Berkeley. The first-year curriculum we developed is displayed in Table 6.

Table 6. Freshman courses at the Model Institute

Fall Semester	**Spring Semester**
Calculus I	Calculus II
Physics I	Physics II
Chemistry I	Other Science
Science Writing/ Other Humanities or SS	Science Writing/ Other Humanities or SS
(Introduction to Engineering)	Elective

This table shows the courses that will be taken by all freshmen at the model Institute.

Academics Conclusion

At this point, we have several important parts of our model developed. We have a list of necessary departments as well as what size those departments will be. We also have a core curriculum that will be completed by all students. The next important characteristic of our model is admissions. This will be a first-rate school, and admissions will be quite selective. We developed our admissions criteria on those of the same top five science and engineering schools discussed previously.

In developing the admissions section of our model, it was necessary to determine whether or not a single-sex school would attract students. Would women apply to our institution? We will now explain the admissions standards and admissions process, and explain why we believe a single-sex school would be successful at attracting students.

Section IV: Admissions

Our model Institute is going to be a first-rate school. Therefore, we want to accept high quality students. We also want to make sure that women would be interested in attending a single-sex institution. The admissions process for our model was developed based on admissions at the California Institute of Technology, the Massachusetts Institute of Technology, Princeton University, Stanford University, and the University of California at Berkeley.

In this next section, we provide a market analysis. Using admissions statistics of the five seven sister schools that are currently single-sex institutions, we determined whether or not women are interested in attending single-sex schools. Afterall, what would be the point of building a first-rate school for women if no women would attend?

Also included in this section we provide some background information about the admissions process at each of the five schools listed previously. Included in this discussion are the testing requirements, expected high school preparation, the option of early notification, application components, and deadlines. The five schools have very similar admissions processes, and our model will be very similar to them as well.

Market Data Summary

An important thing to consider when developing a school is whether or not there is a market for the school. We are developing a women's engineering school. We therefore must ensure that there is a significant number of women that are interested in attending a women's school for engineering.

We looked at the admissions statistics of several women's schools: Barnard College, Bryn Mawr College, Mount Holyoke College, Smith College, and Wellesley College. These results are shown in table M1. Barnard has the highest number of first-year applicants. We assumed that the women who apply to these schools apply to more than one, and possibly all of the women's schools. Therefore, we estimate that the total number of women applying to these women's schools is the number of women who apply at Barnard, the school with the highest number of applicants. For our model, there are 4,380 women applying to women's schools.

Table 7. Admissions Statistics for five women's colleges.

School	Applied	Accepted	Acceptance Rate	Enrolled
Barnard College	4,380	1,201	27 %	560
Bryn Mawr College	1,926	897	46.6 %	358
Mount Holyoke College	2,913	1,642	56.4 %	575
Smith College	2,993	1,694	56.6 %	714
Wellesley College	4,094	1,474	36 %	627

This table shows the number of women who applied to five different women's schools in 2004. It also shows the number of women who were accepted, the percentage of women accepted, and the number of women who actually enrolled at the college.

Totaling the number of women who enrolled at each school in table M1, we found that the number of women who attended these women's schools was about 2,534. Therefore, there were at least 1,846 women in 2004 that applied to these schools but did not attend. According to our model, the Institute will have about 300 freshmen students enroll each year. 300 students per year is reasonable because 300 women is less than 16 percent of the number of women who applied to these other women's schools and did not attend.

Once we determined that women would apply to our model Institute, we developed an admissions process and admissions standards. We used admissions information from five top science and engineering schools in the country. The results may be found in the next section.

Admissions Standards and Application Process

Introduction

Every school has admissions standards, although some schools' standards are higher than others. To determine the admissions standards of the model Institute, we examined the standards of five of the top science and engineering schools in the country: California Institute of Technology, Massachusetts Institute of Technology, Princeton University, Stanford University, and the University of California at Berkeley. The characteristics of the admissions process we examined are: testing requirements, required high school preparation, whether or not there is an early notification option, deadlines, and what is required in the application. We now consider each of these characteristics individually.

Testing Requirements

Standardized test scores are required by all five of the top engineering schools discussed earlier. Caltech, MIT, Stanford, and UC Berkeley require that applicants take either the SAT I of the ACT. Princeton however, only accepts SAT I scores. (They accept ACT scores only if all of the applicant's other college choices require the ACT and not the SAT.) The schools also ask for three SAT II scores. At Stanford, these tests are recommended, while at the four other schools, they are required.

The model Institute will operate at the same level as these schools, so it will have similar testing requirements. Applicants will be required to submit scores for either the SAT I or the ACT. The school will also require three SAT II scores. For engineering majors, all five schools require or recommend a Mathematics SAT II exam. Caltech, Stanford, and UC Berkeley specify that it must be the Mathematics Level IIC exam, while MIT and Princeton will accept either Level IC or Level IIC. The model Institute will require a Mathematics SAT II. Although the applicant will have the choice of which exam to take, Level IIC will be recommended.

For the second SAT II score, most schools require a science exam. Stanford is the exception. Caltech and MIT require one of Biology (Ecological), Biology (Molecular), Chemistry, or Physics. Princeton requires Chemistry or Physics. UC Berkeley does not specify which exam should be taken, only that it should be a science. The model Institute will also require a science SAT II, and the applicant may choose from Biology (Ecological), Biology (Molecular), Chemistry, or Physics.

The third test is sometimes the applicant's choice, but Caltech, Stanford, and UC Berkeley require the Writing exam. The new SAT I will include a Writing section, so this requirement will no longer be necessary. Therefore, the model Institute will not require applicants to submit a Writing SAT II score. Because the Institute will be focused on educating students in the fields of science and engineering, but not all majors will require Chemistry, Biology, and Physics; the third SAT II exam may be taken in a subject of the applicant's choosing. However, for students interested in science or engineering, it will be recommended that this third test be in a science subject.

Table 8. Testing requirements for top science and engineering schools and our model.

	SAT I	SAT II
Caltech	Or ACT	Writing and Mathematics Level IIC and One of: Biology (Ecological), Biology (Molecular), Chemistry, or Physics
MIT	Or ACT	3 Subjects: Mathematics Level IC or Level IIC One of: Biology (Ecological), Biology (Molecular), Chemistry, or Physics
Princeton	Required	3 Subjects: For engineering: Chemistry or Physics and Mathematics Level IC or Level IIC
Stanford	Or ACT	Strongly suggest 3: Writing and Mathematics Level IIC
UC Berkeley	Or ACT	Requires three: Mathematics Level IIC One Science Writing
Model Institute	Or ACT	Requires three: Mathematics Level IC or Level IIC and One of: Biology (Ecological), Biology (Molecular), Chemistry, or Physics Any (Science recommended)

This table shows the standardized testing requirements for five top of the science and engineering schools in the country: Caltech, MIT, Princeton, Stanford, and UC Berkeley. It also shows the testing requirements that will be included in our model.

Required High School Preparation

A certain high school background is expected of students at most schools. We examined the recommended high school preparation of five of the top engineering schools, and from that we developed a recommended background for the model Institute. Berkeley requires their applicants complete certain courses in high school, while the other four schools only recommend certain high school courses. The subjects included in the high school preparation for these five schools are English, Foreign Languages, Mathematics, Science, Social Studies, and Visual and Performing Arts. We now discuss each of these subjects in more detail.

Caltech only requires three years of English, but four is recommended. The other four schools require four years. This appears to be a standard requirement. Stanford specifies that there should be significant emphasis placed on writing and literature, but it is the only school with this specification. The model Institute will require four years of English.

The study of a foreign language in high school is not required by all of the schools examined. Caltech does not require it. MIT does require a foreign language, but does not specify how many years the language must be studied. At Princeton, applicants are expected to have completed four years of study in the same language. Stanford prefers a student complete three or more years in a single foreign language. Berkeley requires two years of the same language, but recommends three. The model Institute will require that applicants have studied foreign language. Two years will be required, but three or more will be highly recommended.

All five schools expect applicants to have a significant background in Mathematics. Caltech recommends four years, which should include Calculus. MIT does not specify the number of years, but the applicant should have completed Calculus. Princeton requires four years of Mathematics with no specifications. Stanford recommends four years, which should include Algebra, Trigonometry, and Geometry. Berkeley requires three years of Mathematics, but recommends four. Four years of Mathematics appears to be standard, so that is what the model Institute will require. Most applicants will be entering science or engineering, and therefore, Calculus will be very important. For this reason, it will be recommended that applicants complete Calculus in high school.

The high school science requirement varies from school to school. Caltech requires one year of Chemistry and one of Physics. MIT requires one year of each Biology, Chemistry, and

Physics. Princeton, Stanford, and Berkeley require laboratory science. For Princeton, the requirement is two years and for Stanford it is three. Berkeley requires two years and recommends three. Because the model Institute will be a science and engineering school, it will require three years of science, with at least one laboratory course.

All five schools require a background in Social Science and/ or History, but there is some variation. Caltech requires one year of United States History or Government, which is waived for international students. MIT applicants are required to complete two years of History and/or Social Sciences. Princeton requires two years of History. Stanford requires three or more years. There must be one year of American History, and the courses should include essay writing. Berkeley requires two years of History and/or Social Science. The average requirement is two years, so the model Institute will require its applicants to complete two years of History or Social Science. Only two schools make specifications about the courses to take, so the model Institute will not make any.

UC Berkeley is the only school that requires applicants to study Visual and Performing Arts. They require one year. The model Institute will not include this subject in its required high school background, but well-rounded students with a broad range of knowledge will be preferred over others. Therefore, applicants should show involvement in areas other than the standard academic subjects. These areas may include, but are not limited to arts, sports, and programming.

After reviewing the high school preparation expected of five of the top science and engineering schools in the country, we determined the required high school preparation for the model Institute. This background, as well as those required by the five schools examined, may be found in the table below.

Table 9. Expected high school preparation at top science and engineering schools.

	English	Foreign Language	Mathematics	Science	Social Science & History	Visual & Performing Arts
Caltech	3 yrs, 4 recommended	none	4yrs, calculus recommended	1yr physics 1yr chemistry	1 yr US History or Gov't.	None

MIT	4 yrs	A language	Through Calculus	1yr physics 1yr chemistry 1yr biology	2yrs	None
Princeton	4 yrs	4yrs, one language	4yrs	2yrs lab	2yrs history	None
Stanford	4 yrs	3+yrs, one language	4 yrs	3+yrs lab	3yrs, 1 American history	None
Berkeley	4 yrs	2 yrs, 3 recommended	3 yrs, 4 recommended	2 yrs lab, 3 recommended	2 yrs	1 yr
Model Institute	4 yrs	2 required 3+ recommended	4 yrs (calculus recommended)	3 yrs (1 yr lab)	2 yrs	None

This table shows the expected high school preparation for five top of the science and engineering schools in the country: Caltech, MIT, Princeton, Stanford, and UC Berkeley. It also shows the expected high school preparation that will be included in our model.

Early Notification

At some schools, there is an option to apply earlier than usual and receive an admissions decision earlier than usual. Sometimes this decision is binding, and other times it is not. To determine whether or not the model Institute should offer an early application process, we looked at the application process of five of the top science and engineering schools. Caltech, MIT, Princeton, and Stanford have an early notification option, while Berkeley does not.

At Caltech, there is an option to apply "Early Action". Students will receive their admissions decision before Regular Action applicants, and the decision is non-binding. Applying Early Action does not increase an applicant's chance of getting accepted. Some students who apply via Early Action will have their admissions decision held for review with the Regular Action applications, but they will be notified of this with the notifications of Early Action admissions and denials.

Students applying to MIT have the option to apply "Early Action". Students may apply and receive an admissions decision earlier than usual. The decisions offered by MIT are acceptance, deference of the decision until the Regular Action applicants have applied, or denial. This decision is non-binding, and if accepted, the applicant may choose whether or not to attend MIT.

Princeton University has an "Early Decision" option for students who view Princeton as their top choice school. This is another application process that allows applicants to receive their admissions decision earlier than usual. This decision, however, is binding. If an Early Decision applicant is accepted to Princeton, they must attend.

Stanford has the option for students to apply via "Single-Choice Early Action". This option is for students who are sure that Stanford is their first choice. Although the admissions decision is non-binding, students may not apply to any other schools under early notification.

Four of the five schools examined offer an early notification option, and only at Princeton is the decision binding. The model Institute will have an early notification option, and students will be able to submit their application for review and receive a decision early. This decision will be non-binding, and if accepted, applicants may then choose whether or not to attend.

Application components

Although there is some variation in the structure of applications, many components are standard. There is always an application form and supplementary components. We examined the supplementary components required by five of the top science and engineering schools in the country to determine what should be required by the model Institute. The components we considered were: Secondary School Reports, Mid-year grade reports, essays, teacher evaluations, and interviews.

Most schools require a Secondary School Report and a mid-year evaluation report. Berkeley, however, is the exception. It does require a Secondary School Report, but asks applicants not to submit it until they have been accepted to the school. Also, Berkeley does not accept mid-year grade reports. The model Institute will follow the standard of the other four schools. A Secondary School Report will be required with the application, and a mid-year grade report will be required at the end of the semester.

All five schools examined require at least one essay in order to learn more about the applicants than their academic transcript and test scores can show. Caltech offers more than one, although the actual number was not available because applications were not available at the time this project was completed. MIT, Princeton, and Berkeley require one long essay and two shorter ones. Stanford only requires one, one-page essay with their application. The model

Institute will follow the example set by MIT, Princeton and Berkeley. It will require three essays, of which one will be long, and two will be shorter. The essays will be used to evaluate the applicant's character and personality, to determine if they are right for the model Institute. The specific topics of the essays will be determined later.

Caltech, MIT, Stanford, and Princeton require two teacher evaluations to learn more about applicants. Berkeley does not require evaluations, nor do they accept them. Caltech requires one evaluation from a math or science teacher and one from a humanities or social science teacher. MIT is similar, but the second evaluation may be from a language teacher as well. Princeton only specifies that the two teachers be from different subjects. Stanford requires that the evaluations be completed by teachers who taught the applicant in the different subjects in the eleventh or twelfth grade. The subjects may be any of the following: English, mathematics, science, foreign language, or history/social science.

The essays and teacher evaluations are not the only way schools learn about an applicant's character. Some schools have interviews. Interviews are not required by any of the five schools examined. They are not even offered at Caltech, Stanford, or Berkeley. MIT and Princeton alumni conduct optional interviews, and recommend that applicants have one. Caltech, Stanford, and Princeton use only the essays and teacher evaluations to judge an applicant's character. These two application components will be sufficient for the model Institute.

The application components that are required by the five top science and engineering schools, as well as those that will be required by the model Institute are summarized in the table below.

Table 10. Application components of top science and engineering schools.

	Secondary School Report	Mid-year grade report	Essay	Teacher Evaluations	Interview
Caltech	Yes	Yes	More than one	2	No
MIT	Yes	Yes	1 long 2 short	2	Optional
Princeton	Yes	Yes	1 long 2 short	2	Suggested
Stanford	Yes	Yes	1 one page	2	Not offered
UC Berkeley	Yes	No	1 long 2 short	Don't send them	No interviews
Model	Yes	Yes	1 long 2 short	2	None

Institute					

This table shows the application components for five top of the science and engineering schools in the country: Caltech, MIT, Princeton, Stanford, and UC Berkeley. It also shows the application components that will be included in our model.

Deadlines

In the admissions process, there is always a timetable with different deadlines for different parts of the application. Some schools have early notification options which have earlier deadlines than regular notification. We examined the timeline of five of the top science and engineering schools and found them quite similar.

The four schools that offered an early notification option have their applications due November 1. Caltech and Stanford require standardized tests to be taken no later than the October deadline for early notification, while MIT and Princeton allow applicants to take these tests in November. All four schools send out their admissions decisions in mid- to late December. The model Institute will follow this standard. For early notification, the application will be due by November 1, tests must be completed by the November test date, and decisions will be sent out in mid-December.

For regular notification there is a little more variation. The deadline for the application is January 1 for Caltech and MIT, January 2 for Princeton, December 15 for Stanford, and November 30 for Berkeley. Caltech, MIT, and Berkeley require standardized tests be taken by the December test date and Princeton and Stanford accept the January one. Admissions decisions are given from Caltech, Princeton, and Stanford in early April. Applicants of MIT and Berkeley receive their decisions in March. Berkeley appears to be an anomaly, so it was not considered in determining the timeline of the model Institute. The application will be due January 1, and tests must completed by the January test date. Applicants will receive their admissions decisions in early April.

The deadlines of the five schools examined, as well as those of the model Institute, may be found in the table below.

Table 11. Application deadlines for top science and engineering schools.

	EA/ED App	EA/ED SAT I/ACT & SAT II	EA/ED decision	RA App	RA SAT I/ACT & SAT II	RA decision
Caltech	Nov 1st	Oct date	Late Dec	Jan 1st	Dec date	Early Apr
MIT	Nov 1st	Nov date	Mid-Dec	Jan 1st	Dec date	Mid-Late Mar
Princeton	Nov 1st	Nov 6th date	Mid-Dec	Jan 2nd	Jan 22nd date	Early Apr
Stanford	Nov 1st	Oct date	Mid-Dec	Dec 15th	Jan date	Early Apr
UC Berkeley				Nov 30th	Dec date	Mar 31st
Model Institute	Nov 1st	Nov date	Mid-Dec	Jan 1st	Jan date	Early Apr

This table shows the application deadlines for five top of the science and engineering schools in the country: Caltech, MIT, Princeton, Stanford, and UC Berkeley. It also shows the application deadlines that will be included in our model.

Admissions Conclusion

We determined that it would be feasible to develop a singe-sex institution. This conclusion is based on admissions statistics at other single-sex schools, such as number of applicants, number of applicants accepted, and number of students who actually enroll.

Our model Institute will follow a similar admissions process as most other top science and engineering schools. There will an early notification option, for which the application will be due in November. For regular notification applicants, the application will not be due until January.

Applicants will be required to submit scores for the SAT I or ACT, as well as three SAT II Subject Tests. These tests must include the Mathematics Level IC or Level IIC and two science tests. Also, applicants will be asked to submit a secondary school report, a mid-year grade report, three essays, and two teacher evaluations. In addition, applicants will be expected to have completed 4 years of English, 2 years of a foreign language, 4 years of mathematics, 3 years of science, and 2 years of social science in high school.

If we had had more time to develop our model, we would have determined the cost for students to attend our institution. We also would have developed a method for applying for Financial Aid, and a way to calculate financial need for students.

Next we will discuss the campus structure of our model. The main topics we have developed are the single academic building, the attached library, and the campus center. We will describe how we determined the size and cost of each building.

Section V: Campus Structure

The structure of the campus is an important part of any school. In our model our main focus was the academic building, the attached library, and the campus center. In developing our academic buliding, we first determined the number of classrooms that would be needed. We also determined the amount of office space and lab space each professor would need. From these numbers, we developed the total size of the academic building. We performed these calculations twice. The first time, we used square footage approximations provided by John Miller, the Director of Physical Plant at Worcester Polytechnic Institute. We then performed the calculations a second time using larger approximations. The results of this second calculation would be a building that had larger laboratories and larger offices. We did this because John Miller's numbers more closely resemble those of WPI, and not those of a first-rate institution.

When we determined the number of faculty and students in our model, we noticed that our institution would be approximately the same size as the California Institute of Technology. Therefore, when we developed our library, we assumed that the amount of library space we would need would be about the same amount that Caltech has.

The campus center in our model was based on that of WPI. Its size and estimated cost to build was determined from information about the building of WPI's campus center. We will now discuss the campus structure in more detail.

The Academic Building using John Miller's numbers

Classrooms/Lecture Halls

Once we determined the number of faculty and students at the model Institute and the courses that freshmen will be taking, we were able to determine the amount of classroom and lecture hall space that would be needed.

Lecture halls will be needed for most freshmen courses and several upper-level courses that large numbers of students take. In the curriculum section, it was determined that most freshmen will take Calculus I and II, Chemistry I, Physics I and II, and Science Writing. Science Writing will be taught in small classes as opposed to the lecture hall environment. The other courses will require lecture hall space for one hour per day, four days each week. Other advanced science courses will also require lecture hall space. We will assume that lecture hall space will be needed for at least 5 additional classes each day. If the lecture halls are in use from 9am until 5pm, with one hour off, it can be assumed that the model Institute will only need two lecture halls. This will accommodate fourteen courses each semester.

The two lecture halls will be designed with a capacity of 300 students. According to John Miller, each student will require 20 square feet of space[1]. Therefore, the lecture halls will be about 6,000 square feet each.

Each classroom will operate 7 hours per day. We calculated the number of classrooms using a procedure suggested by John Miller. We assumed that each classroom would be in use about 80 percent of the time, and while in use, each room will be about 80 percent full with students. Students will be taking 5 4-hour-per-week courses at a time, which means that they will be in classrooms 20 hours each week. Students will average 4 hours of class each day. There are about 1,200 undergraduate students in our model. Also, graduate students will probably be in class for an hour each day, and there are about 800 graduate students in our model. Therefore, our model must provide room for 4,800 undergraduate student hours and 800 graduate student hours. Each classroom is in use for 80 percent of a 7 hour day, which is about

---

[1] John Miller, private communication, based on personal interview on April 8, 2005.

6 hours. Our model building will need space for 933 students per hour. If the classrooms are only 80 percent full, then we divide 933 by 0.8 to get about 1170 students per hour. If the average class size is 30 students, our model will require about 40 classrooms.

About 40 classrooms that hold 30 students each (some classrooms will be larger and some will be smaller, but we use this as a total space estimate) amounts to 1200 student spaces. According to John Miller, each student requires 20 square feet of classroom space. Therefore, our model Institute will need about 24,000 square feet of classroom space.

Space for each Department

In addition to classrooms and lecture halls, the academic building will house department offices, faculty offices and labs, and graduate student offices. Each department will require a significant amount of space. The estimates we used to determine the amount of space that would be needed are as follows: 1000 square feet of lab space per faculty member, 150 square feet of office space per faculty member, 100 square feet of office space per graduate student, a one to one ratio of department staff to department faculty, and 100 square feet of department office space per staff member. We will now discuss the space requirements of each department, in alphabetical order.

The largest department at the model Institute is the Biology department. It is comprised of 38 full-time faculty members, 140 – 145 undergraduates, and 110 – 115 graduate students. Each faculty member will require an office and a lab, and for each faculty member there will be one staff member, who will require department office space. This amounts to:

$$38\,faculty \times \left(150\frac{ft^2 office}{faculty} + 1{,}000\frac{ft^2 lab}{faculty} + 100\frac{ft^2 staff\_space}{faculty}\right) = 47{,}500\,ft^2 \qquad (1)$$

The Biology department will also require office space for the graduate students. The space required will be:

$$115\,grads \times 100\frac{ft^2}{grad} = 11{,}500\,ft^2 \qquad (2)$$

From these calculations, we determined that the Biology department at the model Institute will require about 60,000 square feet of space in the academic building.

The space required by the Biomedical Engineering/ Bioengineering department was determined in the same manner. We used equations (1) and (2) with the different number of faculty and graduate students. There will be 15 faculty members and 45 – 50 graduate students. From these numbers, we determined the total amount of space required to be about 24,000 square feet.

The numbers of faculty and graduate students in the Chemical Engineering department at the model Institute will be 15 and 50, respectively. This size is the same as the Biomedical Engineering/ Bioengineering department, and therefore, these departments will require the same amount of academic space.

The Chemistry department at the model Institute will have 22 faculty members and 65 – 70 graduate students. Using equations (1) and (2), we determined the amount of academic space required for the Chemistry department to be 35,000 square feet.

The department of Civil and Environmental Engineering at the model Institute will be the same size as the Biomedical Engineering/ Bioengineering and Chemical Engineering departments. Therefore, it will require the same amount of academic space.

It will not be necessary for every faculty member in the Computer Science department to have their own lab. However, some computer lab space will be needed. Therefore, we used equation (1), with only 100 square feet of lab space per faculty member to determine the amount of space required. The Computer Science department at the model Institute will be comprised of 32 faculty members and 95 – 100 graduate students. Therefore, the amount of academic space required is the sum of equation (2), for the graduate student space, and the following equation:

$$32\,faculty \times \left(150\frac{ft^2 office}{faculty} + 100\frac{ft^2 lab}{faculty} + 100\frac{ft^2 staff\_space}{faculty}\right) = 11{,}200\,ft^2 \qquad (3)$$

or about 22,000 square feet.

The academic space required for the department of Earth, Planetary, and Astronomical Sciences was determined using equations (1) and (2). There will be 14 faculty members and 40 – 45 graduate students in the department of Earth, Atmospheric, and Planetary Sciences. We determined that 22,000 square feet of academic space will be required for this department.

The department of Electrical Engineering at the model Institute will have 19 faculty members and 55 – 60 graduate students. This space required for this department was also calculated from equations (1) and (2). The amount of required academic space for the Electrical Engineering department is about 30,000 square feet.

There will not be any laboratories or graduate students for the Humanities and Social Sciences department, so the academic space required will be the sum of the space required for the 31 faculty offices and the department office. Using equation (1) and omitting the laboratory space term, we determined the required academic space for the Humanities and Social Sciences department to be about 8,000 square feet.

Laboratories will not be utilized in the Management department, either. Therefore, space will only be required for offices. There will be 13 faculty members, and 35 – 40 graduate students in this department. Using equations (1) and (2) and omitting the lab space term, we calculated the required academic space of the Management department to be about 8,000 square feet.

The Mathematics department will not require a large amount of laboratory space for each faculty member. However, some space will be needed for math conferences and computer labs. Therefore, equations (2) and (3) were used to calculate the amount of academic space that would be needed. There will be 24 faculty members and 70 – 75 graduate students, so about 16,000 square feet of academic space will be required.

The department of Mechanical Engineering at the model Institute will have 16 faculty members and 45 – 50 graduate students. We used equations (1) and (2) to determine the amount of academic space required. The total amount of space is about 25,000 square feet.

There will be 20 faculty members and 60 – 65 graduate students in the model Institute's Physics department. Using equations (1) and (2), we calculated the amount of academic space required to be about 32,000 square feet.

Table 12. The amount of academic space required for each department at the model Institute using John Miller's size estimates.

Department	Number of full-time faculty	Number of Graduate Students	Amount of Academic Space needed
Biology	38	110 – 115	59,000
Bioengineering/ Biomedical Engineering	15	45 – 50	23,750
Chemical Engineering	15	45 – 50	23,750
Chemistry	22	65 – 70	34,500
Civil & Environmental Engineering	15	45 – 50	23,750
Computer Science	32	95 – 100	21,200
Earth, Planetary, and Astronomical Sciences	14	40 – 45	22,000
Electrical Engineering	19	55 – 60	29,750
Humanities & Social Sciences	31	N/A	7,750
Management	13	35 – 40	7,250
Mathematics	24	70 – 75	15,900
Mechanical Engineering	16	45 – 50	25,000
Physics	20	60 – 65	31,500
Total	274	710 – 770	325,100

This table shows the number of faculty members and graduate students that will be in each department at the model Institute. It also shows about how much academic space will be required for each department. These numbers were calculated in the paragraphs above.

Teaching Laboratories

The laboratories discussed briefly above are research laboratories for the faculty members and graduate students. The school will also have teaching laboratories for undergraduate students to learn in. We estimate that students will spend about 6 hours per week in a lab, so each lab station can be used by five people each semester. There are about 1200 undergraduate students. Therefore, the model Institute requires 240 lab stations. Each student requires about 60 square feet for a lab station[1]. Thus, the total amount of teaching lab space required is about 14,400 square feet.

Shops

There will also be shops in our model academic building. There will be approximately two shops per department (some departments will have multiple, and some will not have any).

These shops will be about the same size as the teaching laboratories. Each shop will hold about 40 students. Each student will need 60 square feet. Therefore 2,400 square feet will be needed per shop, and 62,400 square feet will be needed total.

Overall size of the building

The overall size of the building is the sum of the space required for classrooms and lecture halls, department space, teaching labs, and shops. This amount is 36,000 + 325,100 +14,400 + 62,400, or 437,900 square feet.

Space will also be required for mechanical space, corridors, bathrooms, etc. According to John Miller, the ratio of assignable space to actual space needed is 6:10. Therefore, we multiplied 437,900 by 10/6 to determine the total amount of academic space (not including the library). This number is about 730,000 square feet.

Conclusion

Using John Miller's numbers, we determined that the academic building will have 40 classrooms, and be about 1 Million square feet. We will now recalculate the size of the building using a second approach. This new approach is based on the fact that each professor will teach one course each semester. It will also provide larger offices and laboratories.

The Academic Building: A Second Approach

Classrooms/Lecture Halls

For this second approach, the number and size of the lecture halls was not changed. 12,000 square feet of lecture hall space will be used in our model. The teaching lab space and shop space were not changed either. The way we determined the number of classrooms was different. It is based on the number of professors, not the number of students and the number of classes each student takes.

Each of the 31 Humanities and Social Sciences professors will teach three classes every two semesters. The other 243 professors will be doing research, and therefore will teach only one course per semester. This is a total of 305 classes being taught each semester. Each of the classes will require classroom space. At least 10 of the classes may be taught using the available lecture hall space. The other 295 classes will use smaller classrooms.

Each room will operate 7 hours per day. Therefore, the model Institute will need about 43 classrooms. Some classrooms may be smaller than others. Some upper-level, more specific classes will contain fewer students than the broad courses that large numbers of students take. If we assume that twenty-five percent of the classes taught at the Institute will use the smaller classrooms, there should be 17 smaller rooms. These rooms will hold up to 15 students. The other classrooms will hold up to 45 students.

The classroom sizes were determined using John Miller's estimate of 20 square feet per student. Therefore, the 17 classrooms that hold 15 students will require a total of about 5,100 square feet. The other 26 classrooms, which hold 45 students will require a total of about 23,400 square feet.

Space for each Department

For the total department space, we decided to increase the amount of laboratory space per professor from 1,000 square feet to 1,500 square feet, the faculty office space per professor from 150 square feet to 300 square feet, the graduate student office space from 100 to 200 square feet, and the department office space from 100 to 200 square feet per staff member. We revised equations (1), (2), and (3) to form equations (4), (5), and (6). We followed the same procedure as the first set of calculations we these new equations and the results are tabulated in table 13.

$$no.faculty \times \left(300 \frac{ft^2 office}{faculty} + 1{,}500 \frac{ft^2 lab}{faculty} + 200 \frac{ft^2 staff\_space}{faculty} \right) = space(ft^2) \quad (4)$$

$$no.grads \times 200 \frac{ft^2}{grad} = 23{,}000 space(ft^2) \quad (5)$$

$$no.faculty \times \left(300 \frac{ft^2 office}{faculty} + 100 \frac{ft^2 lab}{faculty} + 200 \frac{ft^2 staff\_space}{faculty} \right) = space(ft^2) \quad (6)$$

Table 13. The amount of academic space required for each department at the model Institute.

Department	Number of full-time faculty	Number of Graduate Students	Amount of Academic Space needed
Biology	38	110 – 115	99,000
Bioengineering/ Biomedical Engineering	15	45 – 50	40,000
Chemical Engineering	15	45 – 50	40,000
Chemistry	22	65 – 70	58,000
Civil & Environmental Engineering	15	45 – 50	40,000
Computer Science	32	95 – 100	39,200
Earth, Planetary, and Astronomical Sciences	14	40 – 45	37,000
Electrical Engineering	19	55 – 60	50,000
Humanities & Social Sciences	31	N/A	15,500
Management	13	35 – 40	30,000
Mathematics	24	70 – 75	29,400
Mechanical Engineering	16	45 – 50	42,000
Physics	20	60 – 65	53,000
Total	274	710 – 770	573,100

This table shows the number of faculty members and graduate students that will be in each department at the model Institute. It also shows about how much academic space will be required for each department. These numbers were calculated in the paragraphs above.

Overall size of the building

The overall size of the building is the sum of the space required for classrooms and lecture halls, department space, teaching labs, and shop space. This amount is 40,500 + 573,100 + 14,400 + 62,400, or 690,400 square feet.

Space will also be required for mechanical space, corridors, bathrooms, etc. According to John Miller, the ratio of assignable space to actual space needed is 6:10. Therefore, we multiplied 690,400 by 10/6 to determine the total amount of academic space (not including the library). This number is about 1.15 Million square feet. This estimate is about 58 percent larger than the estimate from John Miller's approach. Now that we have a size estimate for the academic building, we can design the library for our model.

The Library

It was previously determined (in the Department Sizes section) that the model Institute will have approximately the same number of faculty and students as the California Institute of Technology. Therefore, the library at the model Institute was designed based upon information about the libraries at Caltech. There are two main libraries at Caltech, the Millikan Library and the Sherman Fairchild Library. Information about the size of these buildings was only available for the Sherman Fairchild Library. Therefore, we will scale that library up to determine the size of the library at the model Institute.

The purpose of the Sherman Fairchild Library is to support the Engineering and Applied Science departments at Caltech. There are 91 full-time faculty members in Caltech's Division of Engineering and Applied Science (http://www.eas.caltech.edu/fac_a-c.html). There are 283 full-time faculty members in the entire school (http://www.caltech.edu/at-a-glance/). Therefore, the Division of Engineering and Applied Science is about 32 percent of Caltech, and the Sherman Fairchild Library is supporting about 32 percent of the school. This library is 36,619 square feet[1]. If this space is only 32 percent, then the total amount of library space is about 113,881 square feet. Therefore, we estimate that the model Institute's Library will be about 115,000 square feet.

The next part of our model we will develop is the campus center, which we modeled after that of Worcester Polytechnic Institute.

[1] Sherman Fairchild Library of Engineering & Applied Science - http://library.caltech.edu/sherman/architecture.htm

The Campus Center

The model Institute will not be located in a city, but it will be located on the edge of a town. Therefore, the Campus Center will be used to supply students with some things that they will need, and for everything else, they may go to the town. We researched the Campus Centers of three women's schools that are located in suburbs. The schools chosen were Bryn Mawr College in Bryn Mawr, Pennsylvania, which is a suburb of Philadelphia; Mount Holyoke College in South Hadley, Massachusetts; and Smith College in Northampton, Massachusetts.

The Campus Centers at these schools had their differences, but there were many similarities. Some of the characteristics that were common to all three Campus Centers were a mailroom, a bookstore, a café, various offices, and lounge areas. The Campus Center at the model Institute will have all of these.

Some of the other characteristics of the examined Campus Centers were big-screen TVs and fireplaces in the lounges, and computer workspaces with the internet, and function halls. The model Institute may include these options, but our main concern was with the size of the building. These options may be determined later.

The Campus Center at WPI is a good example of what the Campus Center at the model Institute will be. It has everything that the Campus Center will need except for a grocery store. This building is 71,000 square feet. We will estimate the model Institute's Campus Center will be about 80,000 square feet.

WPI's Campus Center cost over $17 million to build[1]. From this number, we calculated the cost per square foot, and then estimated that the Campus Center at the model Institute will cost about $19.5 million to build.

---

[1] WPI Campus Center: Realizing a Dream - http://wpi.edu/Admin/CC/About/Articles/dream.html

Campus Structure Conclusion

We designed the academic building using two different approaches. The first approach, was suggested by John Miller, and bases the number of classrooms on the number of hours students spend in class each day. The second approach bases the number of classrooms on the number of faculty the model Institute will have teaching classes. This second approach also uses larger sizes for research labs, and faculty, graduate student, and department offices. John Miller's approach resulted in an academic building of about 730,000 square feet, while our second approach resulted in 1.15 Million square feet.

The library for our model was designed based on information about the libraries at the California Institute of Technology. The size of our library will be about 115,000 square feet. The Campus Center at our model Institute was developed based on information about that of Worcester Polytechnic Institute. It will be about 80,000 square feet.

If we had had more time, we would have also designed the athletic facilities. There would have been an athletic complex, which might include a swimming pool or an indoor track. There also would have been several fields for soccer, field hockey, and softball. The model may have also included an outdoor track.

Another important part of our model is student life at our Institute. We develop this part in the next section. We will discuss the location and feel of the model Institute, as well as housing, and what it will be like to live in the on-campus residences.

Section VI: Student Life

In order for a school to be successful, students must enjoy being there. Therefore, the location of the school, and the residences that the students live in are very important. In this section, we will develop both of these parts of our model.

We determined the location of our institute by examining the locations of other top science and engineering schools and the seven sister schools. The science and engineering schools are in the Northeast or Southern California. The seven sister schools are all located in the Northeast.

We developed the style of the residences based on those of the top science and engineering schools in the country. We designed the rooms to be at level of a nice hotel. All students will have their own rooms. We now discuss the location for our model Institute and the residences in more detail.

Location of the Model Institute

The Model Institute

When developing a new school, it is important to determine a suitable location. Several things were taken into account when determining the location of the model Institute. The first is what region of the country the school should be in. Once the region is determined, it is important to decide whether or not the school should be in a city, and if not, how far from the nearest city should it be. The look and feel of the campus are also important. For example, a campus could be surrounded by forests, mountains, desert plains, or skyscrapers. Another comfort issue that was considered was the weather. The final concern is whether or not anyone will complain about a school being built in the chosen location. The model Institute will be a women's engineering school. Therefore, the location will be determined by looking at the locations of the top five engineering schools as well as the seven sister schools.

The California Institute of Technology, Massachusetts Institute of Technology, Princeton University, Stanford University, and the University of California Berkeley are the top five engineering schools in the country. Many aspects of the model Institute, including its location, were developed from common characteristics of these schools. The school will only consist of women, so this part of the location was determined by examining the campus of the seven sisters. Only five of the seven sisters are still women's undergraduate schools, so only these schools were used. They are Barnard College, Bryn Mawr College, Mount Holyoke College, Smith College, and Wellesley College.

The region of the country the school should be located in is also important. The seven sisters are the women's equivalent of the Ivy League, so most of them are located in New England. The engineering schools are slightly more diverse. Caltech, Stanford, and UC Berkeley are located in California, MIT is in Massachusetts, and Princeton is in New Jersey. It seems as though the best region to build a women's engineering school is either in Southern California or the New England.

Whether or not the school is built in a major city is also very important. All five of the example engineering schools are in or within an hour of a major city. Building a new school in a city is both expensive and difficult. Property in cities is very desirable for corporations and therefore it costs a lot of money. Also, most major cities are completely developed. It would be very difficult to build an entire college campus in a city without disrupting anything else. If the model Institute were to be built in a city, it would end up consisting of a few buildings close to each other, and possibly some apartments that the school could buy/rent from landlords. There would be no "campus feel" because the school would not be separated from the city in any way. There would not be many trees or much scenery. Another concern that arises when a school is built in a major city is student safety. Crime rates tend to be higher in cities than in suburbs and country towns. Students should feel safe in their residence halls or apartments, and also when they go out at night. Therefore the model Institute will not be constructed in a major city. However, it will be located moderately close to a major city.

Building the school in close proximity to a major city is a good idea for a variety of reasons. One reason is that many engineering students will be looking for summer internships and possibly to work during the school year. Many job opportunities would be possible with a city not too far away. Another reason the school should be built near a city is that it will attract prospective students. Students who enjoy cities but do not necessarily want to go to school in one would be drawn to the idea of being able to go to take day trips to the city to go shopping, clubbing, etc. Meanwhile, students who do not enjoy cities will be far enough away that it will not feel as though they are in a city.

Another thing to consider when choosing a location for a new school is what the campus should look and feel like. Of the seven sister schools examined, only Barnard College is located in a city. It is found in Manhattan, New York City. The other four schools are located in towns and suburbs. Bryn Mawr is in Bryn Mawr, Pennsylvania only 11 miles west of Philadelphia[1]. Its

[1] Bryn Mawr at a Glance - http://www.brynmawr.edu/admissions/at_a_glance.shtml

campus "is widely recognized as one of the most beautiful college campuses in the country"[2]. Both Mount Holyoke and Smith are found in the Pioneer Valley of Massachusetts. Mount Holyoke is in South Hadley[3], and Smith is in Northampton, are both about a two hour-drive from Boston[4]. The Pioneer Valley is known as "one of the most beautiful areas in New England"[5]. At Smith, "students live in large welcoming wood-frame or brick houses on a leafy campus -- complete with a pond and a waterfall -- in the lively New England town of Northampton"[6]. Wellesley is found in Wellesley, Massachusetts, only 12 miles from Boston. The campus consists of "woodlands, hills, meadows, an arboretum, ponds, and miles of footpaths and fitness trails [that] border scenic Lake Waban"[7]. If these schools are a good example, it is important that the campus of a women's school be beautiful and comfortable. If these schools are a good example of what a women's school should be like, the model Institute's campus should be small and consist of buildings, many trees and perhaps a lake or pond. It should be beautiful. It should be a closed-campus, completely separated from any main roads.

There is another aspect of campus feel besides beauty. This is weather. The campus should be comfortable. College students spend a lot of time outside, walking to and from classes, playing sports, etc., so they must be able to enjoy being outside. For this reason, the model Institute will be constructed in an area where students will not be subjected to severe weather. This includes very high or low temperatures, large amounts of precipitation, or natural disasters such as tornadoes or earthquakes.

After all of this information had been taken into account, it was determined that the model Institute will be located somewhere in Southern New Hampshire. The school will be within a 30-minute drive from Nashua. The weather in New Hampshire is not perfect. There is cold weather and precipitation all year long. This will be handled by only having one academic building and having enclosed walkways between the buildings. Therefore, students will not be

[2] About Bryn Mawr - http://www.brynmawr.edu/visit/about.shtml
[3] Mount Holyoke College: About the Region - http://www.mtholyoke.edu/cic/about/region.shtml
[4] Smith College: Visiting Smith - http://www.smith.edu/about_noho.php
[5] Mount Holyoke College: About the Region - http://www.mtholyoke.edu/cic/about/region.shtml
[6] Smith College: How Smith Feels - http://www.smith.edu/about_howsmithfeels.php
[7] Wellesley College: The Campus - http://www.wellesley.edu/Welcome/buildings.html

forced to walk outside in extreme weather. Also, there are not many serious natural disasters in New Hampshire. The most severe natural disasters that occur are hurricanes, which can cause significant damage, but usually do not. Now that we have chosen a location for our model school, we will design the residence halls.

Living on Campus

In our model, we assume that all of the undergraduate students, and about 85 percent of the graduate students will live on campus. These students will require bedrooms, bathrooms, dining facilities, and laundry facilities. We will now calculate the amount of space this will require.

Style of Dormitories

In order to design the Residences at the model Institute, we researched the Residence facilities of five top engineering schools, California Institute of Technology, Massachusetts Institute of Technology, Princeton University, Stanford University, and the University of California, Berkeley. Caltech and MIT uses a system of houses that groups of students live in. Princeton has residential colleges. Each college has a cluster of dormitories, a dining hall, lounges, seminar and study rooms, a library, computing facilities, game and television rooms, and, in some cases, theaters and other spaces for the creative and performing arts. Stanford has a variety of housing options for its students, and Berkeley uses traditional dormitories.

The model Institute resembles Caltech and MIT more than it does Princeton, Stanford or Berkeley. Also, the model Institute is about the same size as Caltech, which is much smaller than Princeton, Stanford and Berkeley. Therefore, housing will be modeled after that of Caltech and MIT. There will be several "houses" that will serve as residences for the students.

What dormitories should have

The dormitories at our model Institute will be much nicer than dormitories currently found at other schools. We are designing our school for the future, and our goal for the residences was to design dorms that would still be desireable 50 years from now.

All of the rooms will be singles. There will be a bed, desk, desk chair, and dresser. Each room will also have a closet. There will be internet and cable TV access in each room for the residents to use. Each resident will be provided with her own full bathroom. Residents will be responsible for keeping these areas clean.

Each house will have its own dining facility. This will help the residents develop bonds toward their housemates, and create unity among them. This is in addition to the personal kitchenettes in each room for students who wish to prepare their own meals. The dining halls will be located on the second floor of the houses, to give residents a nice view.

There will be about 1850 students living on campus. Most students will be eating meals at about the same time, so the dining facilities will be sized accordingly. Some students will dine elsewhere, or at different times, but this will be balanced by the number of faculty that will dine in the dining halls. Southeast Construction built a dining facility for the military that would feed about 1800 people at a time[1]. This dining facility was 30,000 square feet. Also, the Merced County Fair's dining facility is 9850 square feet and has a capacity of 790 people[2]. If this number is scaled up for 1850 people, the size would be about 23,000 square feet. The dining space that will be required by the model Institute will be about 30,000 square feet.

The area in Southern New Hampshire that the school will be located in is not a city. Off-campus laundry facilities will not be available. Therefore, each house at the model Institute will have coin-operated washing machines and dryers.

Residence Space Needed

The rooms at the model Institute will resemble small, single-occupant, motel rooms. As described previously, each room will include a bed, desk, chair, dresser, closet, full bathroom, and kitchenette. According to the Islington Housing Act of 1985, the minimum size for a single-occupant residence with an in-room kitchen facility is 130 square feet. 300 square feet will be the size used for the rooms at the model Institute. There will be about 1850 students living on campus, so 555,000 square feet will be needed for the dormitory rooms. There will also be common areas on the first floor of the houses. For this, we will assume about 75,000 square feet of space will be needed.

The total amount of space needed for the residence buildings is the sum of the space needed for dormitory rooms, dining facilities, and common areas. This total is about 660,000

---

[1] Southeast Construction: Features - September 2004 Swift Military Action - http://southeast.construction.com/features/archive/0409_Feature2.asp

square feet.

Parking Space Needed

There will be about 2000 students at the model Institute, including graduate students. However, freshmen students will not be allowed to have a car on campus unless it is necessary. There will also be about 300 full-time faculty members, and about 900 staff members. All of these people will require a parking space. It will be also necessary to space for admissions parking, visitor parking, etc. Therefore, the amount of necessary parking space was determined based on 3500 parking stalls. We used the zoning codes of the City of Pleasant Hill in California for estimates of stall and aisle sizes. A parking stall for a large car must be at least 8.5 x 19 feet, and the aisle between rows of stalls must be at least 25′ [3]. Therefore, a row of stalls, an aisle, and another row of stalls totals 63′ if the stalls are perpendicular to the aisles. For every 2 parking spaces, 63′ x 8.5′ is required. For 3500 parking spaces, about 940,000 square feet is required. The number will be rounded up to 1 million square feet to account for the aisles that will connect one row of stalls to another.

---

[2] Merced County Fair: Rental Rates & Information - http://www.mercedcountyfair.com/pages/facilities2.html
[3] City of Pleasant Hill, California: Community Development Zoning Codes - http://www.pleasanthill.ca.gov/CommunityDevelopment/35-17.cfm

Student Life Conclusion

In order for a school to be successful, students must be happy there. Two important characteristics of a school that affect the happiness of the students are the location of the school, and the quality of the residences.

Our model Institute will be located in Southern New Hampshire, about a half hour from Nashua. Here, students will live in a small town, on a beautiful campus, and they will only be a short drive from the city. The worst part about living in Southern New Hampshire is the extreme weather. Our model Institute will have enclosed walkways connecting buildings, so that students will not be exposed to extreme weather.

The residences at our model school will make the students very comfortable. There are several houses in which students can choose to live. Each has a separate identity. Each house has its own dining hall. The rooms were designed to resemble nice hotel rooms. They are all single rooms with kitchenettes and full bathrooms. Also, there will be enough parking for each student to have a parking space at all times.

If we had had more time, we would have developed the athletics department for our model. There would have been NCAA Division III intercollegiate athletics, as well as club and intramural sports. There will also be physical education classes for students to take.

Another important issue that arises when developing a new school is cost. In the next section, we discuss how much it will cost to construct our model Institute.

Section VII: Funding the Institute

Developing a new school will cost a lot of money. There are construction costs for the academic building, the residence houses, the library, the campus center, etc. There are also Professor's salaries. The model Institute will need an endowment that can support the school for years to come. In this section we discuss the construction costs of the Institute, the amount of money that Professors will be paid, and also the size of the endowment that the model Institute will require.

Construction costs

We determined the construction costs for the academic building and the library by using information from a study done by Lisa Fay Matthiessen and Peter Morris. Their study was titled "Costing Green: A Comprehensive Cost Database and Budgeting Methodology"[1]. In this study, they compared the cost of building academic buildings with and without energy and the environment considerations. Matthiessen and Morris's report contains information about the average cost per square foot of classroom space, laboratory space, wet laboratory space, and library space. We used this information to do our construction cost analysis.

Academic Building

The academic building will be comprised mostly of classrooms, offices, and laboratories. To determine the construction cost, we calculated the amount of lab space and multiplied it by the average cost to build a lab per square foot. We then assumed that the cost to build the rest of the building would be about the same as the cost to build classrooms, and multiplied the total space by the cost to build a square foot of classroom.

There will be about 260,800 square feet of laboratory space at the model Institute. According to Matthiessen and Morris's report laboratories cost about $325 per square foot to build. Therefore, the model Institute's labs will cost about $85 million. The total academic building space is about 1.15 million square feet. Therefore, the space that will not be used for labs is about 890,000 square feet. We multiplied this by Matthiessen and Morris's cost per square foot to build classroom space, which is about $250. The result was about $222.5 million. Therefore, the total cost of the model Institute's academic building will be about $300 million.

Library

The library at the model Institute will be about 115,000 square feet. According to Matthiessen and Morris's report, college libraries cost about $250 per square foot to build. Therefore, the library at the model Institute will cost about $28,750,000.

Residence Halls

[1] Costing Green: A Comprehensive Cost Database and Budgeting Methodology

Our cost analysis of the residence halls was based on information about the cost to build hotel rooms. Jeff Coy and Bill Horalson wrote an article entitled "What's if Going to Cost to Build a Hotel With an Indoor Waterpark?". Our residence halls will not include an indoor waterpark, but this article contains construction costs, furnishing costs, and pre-opening and operating capital costs per room for regular hotels.

We decided that the residence halls will be about the same quality as a Holiday Inn or Best Western. According to Coy and Haralson's article, the average construction, furnishing, and pre-opening and operating costs per room of these hotels are $65,400, $10,800, and $3,600, respectively. Therefore, the total cost per room is $79,800. There will be about 1850 students living in the residence halls at the model Institute, which means the total cost would be about $147,630,000. We rounded this number up to $150 million.

The cost to build the dining halls was determined separately. The dining hall space will be about 30,000 square feet. In order to calculate the cost of building this dining facility, we used the costs per square foot that were estimated for the Construction of Rock Eagle 4-H Center Dining Hall[2]. These estimates were $8.90 per square foot for architecture and design, $126.70 per square foot for construction, and $31.00 per square foot for building operations and equipment. This is a total of $166.60 per square foot. Therefore the dining facility at the model Institute will cost about $5 million.

Campus Center

It was determined previously that the model Institute's Campus Center will cost about $19.5 million.

Parking

[2] Georgia 4-H Foundation: Giving to 4-H - http://www.georgia4hfoundation.org/giving/Dining%20Hall.htm

The model Institute will have about 1 million square feet of parking lot. According to UC Berkeley, parking lots cost about $10,000 per space to build[3]. This is about $38 per square foot. Therefore, the model Institute's parking lot will cost about $38 million.

Administration and Support Space

The administrative building will be about 62,500 square feet. This building will be mainly offices. The cost to build office space is about the same as the cost to build classroom space, $250 per square foot. Therefore, the cost of the administrative building will be about $16 million.

Conclusion

The total construction cost of the model Institute will be the sum of the costs of the academic building, the library, the residence halls, the campus center, and the parking lot. This total comes to about $561 million. The Athletic facility costs would be added if we had had more time.

---

[3] Resources and Existing Data on Parking Costs: Examples of Parking Costs - http://dcrp.ced.berkeley.edu/students/rrusso/parking/Developer%20Manual/Costs/data_on_costs.htm

Professorships

Our model must also include money to pay Professors. There will be about 280 full-time Professors at the model Institute. These will be top-rate Professors who will expect top-rate salaries. In order to determine the amount of money Professors should be paid, we looked the Professors with the highest salaries at other first-rate schools. We were only able to find the salary of one Professor who was not retired. This Professor is Edward Stone, a David Morrisroe Professor of Physics at California Institute of Technology[1]. His total annual compensation is $278,000. Stone is the highest paid Professor at the Institute. Therefore, we will assume that $278,000 will be higher than the average salary at the model Institute. The average salary will be about $100,000. Therefore, about $30 million will be needed each year to pay Professors' salaries. If we assume that there will be a 5 percent return rate on our endowment, we will need about $600 million in our endowment for professor's salaries.

---

[1] Trustees of Princeton University Form 990

Endowment

It was determined earlier that our model Institute will be about the same size as the California Institute of Technology. Therefore, an endowment that is sufficient to fund Caltech would also be sufficient to support our model Institute. Caltech has been in existence since 1891[1]. It has been a very successful school. We used GuideStar.com to obtain a copy of Caltech's form 990. This form shows that the endowment of Caltech is about $1.8 billion. Therefore we will use an endowment of $1.8 billion in our model. There will also be some additional money needed for start-up costs.

---

[1] California Institute of Technology Undergraduate Admissions: Caltech History - http://admissions.caltech.edu/about/history/

Funding Conclusion

Funding a school is very expensive. Construction of the academic building, the library, the residence houses, the campus center, the parking area, and administration and support space will cost about $541 million.

Another expensive part of funding a school is the salaries of the Professors. Our model Institute will have about 280 full-time professors, and each professor will be paid about $100,000 each year. Our model Institute will pay about $30 million each year in professors' salaries.

The endowment of our model Institute will be the same as that of Caltech. It has been successful for Caltech, which is about the same size as our model school. The endowment will be about $1.8 billion.

Section VIII: Conclusion

The purpose of this project was to develop a model for a first-rate technical university for women, with the intentions of increasing the number of female engineers. We developed the academics, admissions, campus structure, and student life for our model school. We then developed a cost analysis.

When developing the academics for our model school, we used information about Caltech, MIT, Princeton, Stanford, and UC Berkeley. From this information, we determined which departments our model would include, the number of students and faculty members that would be in each department, and a core curriculum for all women who attend our model Institute.

We also used the same five schools used in the academics section to develop the admissions standards and process for our model school. In this section, we developed an application process with several application components and certain deadlines.

In developing the campus structure for our model, we designed a single academics building. We determined the number and size of classrooms and lecture halls, as well as the amount of laboratory and office space. We also determined the size of the library and campus center for our model.

Students must be happy at a school for the school to be successful. Therefore, we spent some time determining the best location for our model Institute, and what the residences should be like. We decided that the school will be located in southern New Hampshire. The residences will be houses that students will belong to, and each house will have their own characteristics. Students will have their own rooms with kitchenettes and full bathrooms. Each house will have its own dining facility.

Once all of these sections had been developed, we were able to do a cost analysis. We estimated the cost to construct the buildings to be about $541 million. We also determined, based on that of Caltech, that the endowment used for our model should be about $1.8 billion.

The model we have presented is a preliminary design for a technical university for women. We believe that if this school were constructed, women would attend. Perhaps women who would not have entered an engineering field at a coeducational school, would attend our school as engineering students. Our belief is that this would result in an increase in the number of women engineers.

Appendix A: Departments at the Model Institute and at top Engineering Schools

The Model Institute

Aeronautics & Astronautics
Astronomy
Bioengineering
Biology
Chemical Engineering
Chemistry
Civil & Environmental Engineering
Computer Science
Earth & Planetary Sciences
Electrical Engineering
Humanities & Social Sciences
Management
Materials Science & Engineering
Mathematics
Mechanical Engineering
Physical Education
Physics

California Institute of Technology

- Biology
- Chemistry & Chemical Engineering
  - Chemistry
  - Chemical Engineering
  - Biochemistry and Molecular Biophysics
  - Environmental Science and Engineering
  - Bioengineering
- Engineering & Applied Science
  - Aeronautics (GALCIT)
  - Applied & Computational Mathematics
  - Applied Mechanics
  - Applied Physics
  - Bioengineering
  - Civil Engineering
  - Computation & Neural Systems
  - Computer Science
  - Control & Dynamic Systems
  - Electrical Engineering
  - Environmental Science & Engineering
  - Materials Science
  - Mechanical Engineering
- Geological & Planetary Sciences
  - Earth and Planetary Sciences
  - Environmental Science and Engineering
- Humanities & Social Sciences
- Physics, Mathematics & Astronomy
  - Physics
  - Mathematics
  - Astronomy

Massachusetts Institute of Technology

- Aeronautics and Astronautics
- Architecture
- BE Biological Engineering Division
- Biology
- Brain and Cognitive Sciences
- Chemical Engineering
- Chemistry
- Civil and Environmental Engineering
- CMS Comparative Media Studies
- Earth, Atmospheric, and Planetary Sciences
- Economics
- Electrical Engineering and Computer Science
- ESD Engineering Systems Division
- HST Health Sciences and Technology
- Humanities
  - Anthropology
  - Foreign Languages and Literatures
  - History
  - Literature
  - Music and Theater Arts
  - Writing and Humanistic Studies
- Linguistics and Philosophy
- Materials Science and Engineering
- Mathematics
- Mechanical Engineering
- MAS Media Arts and Sciences
- Nuclear Science and Engineering
- Ocean Engineering
- Physics
- Political Science
- STS Science, Technology, and Society
- Sloan School of Management
- Urban Studies and Planning

Princeton University

Anthropology
School of Architecture
Art and Archaeology
Astrophysical Sciences
Chemical Engineering
Chemistry

Civil and Environmental Engineering
Classics
Comparative Literature
Computer Science
East Asian Studies
Ecology and Evolutionary Biology
Economics
Electrical Engineering
English
French and Italian
Geosciences
German
History
Mathematics
Mechanical and Aerospace Engineering
Molecular Biology
Music
Near Eastern Studies
Operations Research and Financial Engineering
Philosophy
Physics
Politics
Psychology
Religion
Slavic Languages and Literatures
Sociology
Spanish and Portuguese Languages and Cultures
Woodrow Wilson School of Public and International Affairs

Stanford University

School of Earth Sciences
- Geological & Environmental Sciences
- Geophysics
- Petroleum Engineering

School of Engineering
- Aeronautics & Astronautics
- Bioengineering
- Chemical Engineering
- Civil & Environmental Engineering
- Computer Science
- Electrical Engineering
- Management Science & Engineering
- Materials Science and Engineering
- Mechanical Engineering

School of Humanities & Sciences
- Anthropological Sciences
- Applied Physics
- Art & Art History
- Asian Languages
- Biological Sciences
- Chemistry
- Classics
- Communication
- Comparative Literature
- Cultural & Social Anthropology
- Drama
- Economics
- English
- French & Italian
- German Studies
- History
- Italian and French
- Linguistics
- Mathematics
- Music
- Philosophy
- Physics
- Political Science
- Psychology
- Religious Studies
- Slavic Languages & Literature
- Sociology
- Spanish & Portuguese
- Statistics

University of California, Berkeley

African American Studies
Agricultural and Environmental Chemistry
Agricultural and Resource Economics
American Studies
Ancient History and Mediterranean
Archaeology
Anthropology
Applied Science and Technology
Architecture
Asian American Studies
Asian Studies
Astronomy
Bioengineering
Biology
Biophysics
Biostatistics
Buddhist Studies
Business Administration
Celtic Studies
Chemical Engineering
Chemistry
Chicano Studies

City and Regional Planning
Civil and Environmental Engineering
Classics
Cognitive Science
College Writing Programs
Comparative Biochemistry
Comparative Literature
Computer Science
Dance
Demography
Development Studies
Dutch Studies
Earth and Planetary Science
East Asian Languages and Cultures
Economics
Education
Electrical Engineering and Computer Sciences
Endocrinology
Energy and Resources Group
Engineering Science
English
Environmental Health Sciences
Environmental Science, Policy and Management
Environmental Sciences
Epidemiology
Ethnic Studies
Ethnic Studies Graduate Group
Film
Folklore
French
Gender and Women's Studies
Geography
German
Health Services and Policy Analysis
History
History of Art
Industrial Engineering and Operations Research
Infectious Diseases and Immunity
Information Management and Systems
Integrative Biology
Interdepartmental Studies
Interdisciplinary Studies
International and Area Studies
Italian Studies
Joint Medical Program, UCB-UCSF
Journalism
Landscape Architecture and Environmental Planning
Latin American Studies
Legal Studies
Linguistics
Logic and the Methodology of Science
Manufacturing Engineering
Mass Communications
Materials Science and Engineering
Mathematics
Mechanical Engineering
Medieval Studies
Microbiology
Middle Eastern Studies
Military Officers' Education Program (ROTC)
Mineral Engineering
Molecular and Biochemical Nutrition
Molecular and Cell Biology
Molecular Toxicology
Music
Native American Studies
Near Eastern Studies
Nepali
Neuroscience
Nuclear Engineering
Nutritional Sciences and Toxicology
Optometry
Peace and Conflict Studies
Philosophy
Physical Education
Physics
Plant and Microbial Biology
Political Economy of Industrial Societies
Political Science
Practice of Art
Psychology
Public Health
Public Policy
Range Management
Religious Studies
Rhetoric
Romance Languages and Literatures
Scandinavian
Science and Mathematics Education
Slavic Languages and Literatures
Social Welfare
Sociology
Sociology and Demography
South and Southeast Asian Studies
Spanish and Portuguese
Statistics
Theater, Dance, and Performance Studies
Undergraduate and Interdisciplinary Studies
Urban Design
Visual Studies
Wood Science and Technology

Appendix B

This appendix includes the tables of degrees offered in each science and engineering field each year.

Aeronautical/astronautical engineering	B2
Astronomy	B3
Biology	B4
Chemical Engineering	B5
Chemistry	B6
Civil Engineering	B7
Computer Science	B8
Earth, Atmospheric and Planetary Science	B9
Electrical Engineering	B10
Materials Science	B11
Mathematics	B12
Mechanical Engineering	B13
Physics	B14

Table 27. Aeronautical/astronautical engineering degrees awarded, by degree level and sex of recipient: 1966-2001

Academic year ending	Bachelor's			Master's			Doctoral		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
1966	1,683	1,678	5	798	792	6	109	109	0
1967	1,914	1,900	14	802	800	2	142	142	0
1968	2,072	2,060	12	841	835	6	166	165	1
1969	2,625	2,606	19	835	828	7	197	197	0
1970	2,756	2,736	20	749	746	3	204	202	2
1971	2,443	2,426	17	717	711	6	198	195	3
1972	2,180	2,160	20	687	680	7	181	181	0
1973	1,738	1,720	18	563	561	2	167	165	2
1974	1,210	1,192	18	557	548	9	148	145	3
1975	1,174	1,150	24	477	470	7	141	139	2
1976	1,009	980	29	479	469	10	122	122	0
1977	1,078	1,050	28	385	377	8	115	112	3
1978	1,186	1,125	61	411	400	11	103	102	1
1979	1,386	1,320	66	372	355	17	81	81	0
1980	1,424	1,342	82	382	373	9	81	80	1
1981	1,809	1,680	129	408	388	20	97	97	0
1982	2,120	1,949	171	521	482	39	86	85	1
1983	2,127	1,955	172	491	454	37	106	104	2
1984	2,534	2,359	175	562	535	27	119	117	2
1985	2,854	2,613	241	605	574	31	124	119	5
1986	2,902	2,654	248	621	578	43	118	117	1
1987	2,989	2,741	248	737	682	55	142	132	10
1988	3,092	2,794	298	797	734	63	150	141	9
1989	2,944	2,643	301	855	791	64	178	170	8
1990	3,048	2,705	343	1,029	947	82	192	188	4
1991	2,869	2,545	324	941	855	86	207	198	7
1992	2,996	2,658	338	933	850	83	234	217	8
1993	2,735	2,419	316	1,047	941	106	228	218	8
1994	2,330	2,035	295	1,038	938	100	230	219	11
1995	1,771	1,541	230	821	722	99	252	237	14
1996	1,642	1,395	247	774	682	92	287	262	24
1997	1,290	1,088	202	625	550	75	273	254	16
1998	1,247	1,050	197	584	503	81	242	226	15
1999	--	--	--	--	--	--	207	189	17
2000	1,267	1,029	238	560	484	76	214	191	21
2001	1,498	1,194	304	611	521	90	203	174	28

KEY: -- = Detailed national data were not released for the academic year ending 1999 by the National Center for Education Statistics.

NOTES: See section C for specific fields that are included in this field of study.

Details may not sum to totals because of missing information on gender for some recipients.

SOURCES: Tabulated by National Science Foundation/Division of Science Resources Statistics; data from Department of Education/National Center for Education Statistics: Integrated Postsecondary Education Data System Completions Survey; and NSF/SRS: Survey of Earned Doctorates

Table 36. Astronomy degrees awarded, by degree level and sex of recipient: 1966-2001

Academic year ending	Bachelor's			Master's			Doctoral		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
1966	86	76	10	59	50	9	66	63	3
1967	100	89	11	69	58	11	64	59	5
1968	115	93	22	80	68	12	98	89	9
1969	118	107	11	107	100	7	112	105	7
1970	139	120	19	92	83	9	111	103	8
1971	136	127	9	108	94	14	113	105	8
1972	159	135	24	167	155	12	129	121	8
1973	143	117	26	92	80	12	131	125	6
1974	179	144	35	89	77	12	133	127	6
1975	143	115	28	113	98	15	131	119	12
1976	166	149	17	89	81	8	150	139	11
1977	152	131	21	81	67	14	120	111	9
1978	128	102	26	95	83	12	138	131	7
1979	120	100	20	116	101	15	115	107	8
1980	122	98	24	79	70	9	121	108	13
1981	129	103	26	58	49	9	109	98	11
1982	113	92	21	80	69	11	102	86	16
1983	96	72	24	68	56	12	115	100	15
1984	95	75	20	67	57	10	98	86	12
1985	119	89	30	91	76	15	100	89	11
1986	149	126	23	83	72	11	109	100	9
1987	130	107	23	71	55	16	100	87	13
1988	126	107	19	88	71	17	130	114	16
1989	164	127	37	100	85	15	113	96	17
1990	140	97	43	105	83	22	128	108	20
1991	151	112	39	98	79	19	125	110	14
1992	138	97	41	113	81	32	134	114	19
1993	167	120	47	135	106	29	145	120	25
1994	163	117	46	129	98	31	144	119	25
1995	169	117	52	119	88	31	173	143	30
1996	148	93	55	115	88	27	192	151	41
1997	140	94	46	93	61	32	198	161	37
1998	168	110	58	101	71	30	207	162	45
1999	--	--	--	--	--	--	159	126	33
2000	160	106	54	102	77	25	185	145	40
2001	240	145	95	93	57	36	186	145	41

KEY: -- = Detailed national data were not released for the academic year ending 1999 by the National Center for Education Statistics.

NOTES: See section C for specific fields that are included in this field of study.

Details may not sum to totals because of missing information on gender for some recipients.

SOURCES: Tabulated by National Science Foundation/Division of Science Resources Statistics; data from Department of Education/National Center for Education Statistics: Integrated Postsecondary Education Data System Completions Survey; and NSF/SRS: Survey of Earned Doctorates

Table 49. Biological science degrees awarded, by degree level and sex of recipient: 1966-2001

Academic year ending	Bachelor's			Master's			Doctoral		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
1966	23,477	16,143	7,334	4,224	3,077	1,147	2,135	1,818	317
1967	25,476	17,686	7,790	4,988	3,707	1,281	2,360	1,971	389
1968	28,710	19,993	8,717	5,517	3,963	1,554	2,827	2,351	476
1969	32,388	22,663	9,725	5,765	4,096	1,669	3,092	2,566	526
1970	34,303	24,061	10,242	5,835	3,991	1,844	3,361	2,846	515
1971	36,033	25,462	10,571	5,756	3,813	1,943	3,654	3,023	631
1972	37,638	26,491	11,147	6,126	4,099	2,027	3,600	2,957	643
1973	42,672	29,848	12,824	6,294	4,370	1,924	3,648	2,890	758
1974	48,856	33,478	15,378	6,581	4,567	2,014	3,484	2,745	739
1975	52,236	34,820	17,416	6,591	4,615	1,976	3,497	2,691	806
1976	54,913	35,794	19,119	6,621	4,518	2,103	3,573	2,770	803
1977	54,193	34,474	19,719	7,154	4,738	2,416	3,484	2,697	787
1978	52,213	31,990	20,223	6,851	4,421	2,430	3,516	2,623	893
1979	49,576	29,471	20,105	6,879	4,287	2,592	3,646	2,695	951
1980	47,111	27,135	19,976	6,536	4,111	2,425	3,803	2,750	1,053
1981	44,046	24,460	19,586	6,015	3,675	2,340	3,803	2,716	1,087
1982	42,427	23,064	19,363	5,931	3,450	2,481	3,893	2,752	1,141
1983	40,883	21,926	18,957	5,741	3,236	2,505	3,741	2,508	1,233
1984	39,639	20,948	18,691	5,440	3,010	2,430	3,880	2,665	1,215
1985	39,405	20,435	18,970	5,095	2,666	2,429	3,793	2,555	1,238
1986	39,509	20,396	19,113	5,048	2,629	2,419	3,807	2,527	1,280
1987	39,047	20,039	19,008	4,999	2,555	2,444	3,839	2,479	1,360
1988	37,688	18,608	19,080	4,810	2,439	2,371	4,111	2,606	1,505
1989	36,949	18,295	18,654	4,953	2,491	2,462	4,116	2,574	1,542
1990	38,040	18,631	19,409	4,893	2,393	2,500	4,328	2,713	1,615
1991	40,351	19,715	20,636	4,806	2,315	2,491	4,649	2,863	1,773
1992	43,892	21,121	22,771	4,848	2,318	2,530	4,799	2,952	1,831
1993	47,989	23,145	24,844	4,840	2,374	2,466	5,092	3,014	2,050
1994	52,321	25,341	26,980	5,276	2,496	2,780	5,202	3,075	2,109
1995	56,890	26,972	29,918	5,495	2,637	2,858	5,376	3,132	2,217
1996	62,081	29,216	32,865	6,286	2,945	3,341	5,723	3,286	2,415
1997	65,139	29,873	35,266	6,594	3,076	3,518	5,789	3,262	2,495
1998	67,112	30,011	37,101	6,368	3,014	3,354	5,846	3,295	2,536
1999	--	--	--	--	--	--	5,582	3,171	2,394
2000	64,904	26,946	37,958	6,325	2,815	3,510	5,854	3,226	2,622
2001	62,089	25,005	37,084	6,487	2,732	3,755	5,687	3,132	2,547

KEY: -- = Detailed national data were not released for the academic year ending 1999 by the National Center for Education Statistics.

NOTES: See section C for specific fields that are included in this field of study.

Details may not sum to totals because of missing information on gender for some recipients.

SOURCES: Tabulated by National Science Foundation/Division of Science Resources Statistics; data from Department of Education/National Center for Education Statistics: Integrated Postsecondary Education Data System Completions Survey; and NSF/SRS: Survey of Earned Doctorates

Table 28. Chemical engineering degrees awarded, by degree level and sex of recipient: 1966-2001

Academic year ending	Bachelor's			Master's			Doctoral		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
1966	2,981	2,958	23	1,072	1,065	7	367	365	2
1967	2,997	2,969	28	1,028	1,021	7	330	327	3
1968	3,395	3,365	30	1,251	1,237	14	377	374	3
1969	3,768	3,715	53	1,227	1,216	11	422	419	3
1970	3,995	3,938	57	1,127	1,109	18	457	454	3
1971	3,907	3,843	64	1,200	1,173	27	407	403	4
1972	3,967	3,887	80	1,259	1,230	29	391	389	2
1973	3,968	3,874	94	1,139	1,117	22	424	420	4
1974	3,826	3,706	120	1,111	1,080	31	418	409	9
1975	3,420	3,273	147	1,078	1,051	27	396	391	5
1976	3,543	3,254	289	1,129	1,088	41	335	327	8
1977	3,986	3,534	452	1,179	1,110	69	329	319	10
1978	5,205	4,453	752	1,335	1,245	90	282	277	5
1979	6,442	5,387	1,055	1,276	1,156	120	315	306	9
1980	7,276	5,989	1,287	1,393	1,249	144	316	302	14
1981	7,639	6,274	1,365	1,406	1,230	176	317	306	11
1982	8,059	6,447	1,612	1,409	1,222	187	333	314	19
1983	8,550	6,761	1,789	1,545	1,369	176	392	369	23
1984	9,192	7,115	2,077	1,798	1,590	208	409	382	27
1985	8,941	6,848	2,093	1,814	1,529	285	504	463	41
1986	7,411	5,805	1,606	1,641	1,401	240	531	470	61
1987	6,114	4,574	1,540	1,386	1,143	243	584	524	60
1988	4,654	3,522	1,132	1,322	1,107	215	685	620	65
1989	4,187	3,017	1,170	1,321	1,092	229	712	632	80
1990	3,834	2,745	1,089	1,205	1,013	192	658	580	78
1991	3,728	2,564	1,164	1,025	852	173	691	605	83
1992	4,123	2,854	1,269	1,145	914	231	725	609	113
1993	4,899	3,335	1,564	1,220	996	224	737	638	94
1994	5,636	3,953	1,683	1,287	1,008	279	725	609	113
1995	6,391	4,367	2,024	1,369	1,063	306	708	597	109
1996	6,708	4,537	2,171	1,416	1,110	306	798	653	143
1997	6,977	4,701	2,276	1,345	1,013	332	767	641	122
1998	6,721	4,525	2,196	1,372	1,028	344	776	630	140
1999	--	--	--	--	--	--	674	550	123
2000	6,219	4,016	2,203	1,352	1,008	344	724	570	151
2001	6,088	4,033	2,055	1,368	1,016	352	727	545	180

KEY: -- = Detailed national data were not released for the academic year ending 1999 by the National Center for Education Statistics.

NOTES: See section C for specific fields that are included in this field of study.

Details may not sum to totals because of missing information on gender for some recipients.

SOURCES: Tabulated by National Science Foundation/Division of Science Resources Statistics; data from Department of Education/National Center for Education Statistics: Integrated Postsecondary Education Data System Completions Survey; and NSF/SRS: Survey of Earned Doctorates

Table 37. Chemistry degrees awarded, by degree level and sex of recipient: 1966-2001

Academic year ending	Bachelor's			Master's			Doctoral		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
1966	9,735	7,934	1,801	1,839	1,484	355	1,594	1,496	98
1967	9,872	8,101	1,771	1,831	1,484	347	1,773	1,655	118
1968	10,847	8,882	1,965	2,014	1,596	418	1,803	1,662	141
1969	11,807	9,651	2,156	2,070	1,689	381	1,967	1,820	147
1970	11,617	9,501	2,116	2,146	1,666	480	2,238	2,056	182
1971	11,183	9,088	2,095	2,284	1,792	492	2,211	2,036	175
1972	10,721	8,601	2,120	2,259	1,754	505	2,019	1,816	203
1973	10,226	8,259	1,967	2,230	1,763	467	1,855	1,676	179
1974	10,525	8,413	2,112	2,138	1,664	474	1,797	1,620	177
1975	10,649	8,264	2,385	2,006	1,590	416	1,776	1,582	194
1976	11,107	8,610	2,497	1,796	1,413	383	1,624	1,435	189
1977	11,322	8,720	2,602	1,775	1,327	448	1,571	1,391	180
1978	11,474	8,593	2,881	1,892	1,447	445	1,544	1,349	195
1979	11,643	8,530	3,113	1,765	1,318	447	1,566	1,347	219
1980	11,446	8,169	3,277	1,733	1,286	447	1,538	1,283	255
1981	11,540	8,065	3,475	1,667	1,194	473	1,612	1,376	236
1982	11,316	7,703	3,613	1,758	1,261	497	1,680	1,407	273
1983	11,039	7,303	3,736	1,632	1,167	465	1,758	1,461	297
1984	10,912	7,087	3,825	1,677	1,139	538	1,765	1,445	320
1985	10,701	6,807	3,894	1,734	1,166	568	1,836	1,474	362
1986	10,317	6,573	3,744	1,764	1,165	599	1,903	1,507	396
1987	9,830	6,156	3,674	1,750	1,181	569	1,975	1,569	406
1988	9,158	5,506	3,652	1,702	1,148	554	2,015	1,588	427
1989	8,822	5,391	3,431	1,800	1,131	669	1,970	1,471	499
1990	8,289	4,965	3,324	1,711	1,038	673	2,100	1,597	503
1991	8,461	5,046	3,415	1,676	993	683	2,194	1,672	517
1992	8,829	5,236	3,593	1,791	1,090	701	2,213	1,620	579
1993	9,109	5,365	3,744	1,853	1,110	743	2,137	1,530	582
1994	9,641	5,672	3,969	2,010	1,183	827	2,257	1,621	625
1995	10,016	5,783	4,233	2,105	1,220	885	2,162	1,488	661
1996	10,713	6,091	4,622	2,273	1,275	998	2,149	1,526	605
1997	10,926	6,043	4,883	2,268	1,341	927	2,148	1,523	613
1998	10,873	5,900	4,973	2,173	1,175	998	2,216	1,509	695
1999	--	--	--	--	--	--	2,132	1,493	632
2000	10,390	5,483	4,907	1,908	1,085	823	1,989	1,361	624
2001	9,822	5,047	4,775	2,009	1,184	825	1,980	1,349	628

KEY: -- = Detailed national data were not released for the academic year ending 1999 by the National Center for Education Statistics.

NOTES: See section C for specific fields that are included in this field of study.

Details may not sum to totals because of missing information on gender for some recipients.

SOURCES: Tabulated by National Science Foundation/Division of Science Resources Statistics; data from Department of Education/National Center for Education Statistics: Integrated Postsecondary Education Data System Completions Survey; and NSF/SRS: Survey of Earned Doctorates

Table 29. Civil engineering degrees awarded, by degree level and sex of recipient: 1966-2001

Academic year ending	Bachelor's			Master's			Doctoral		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
1966	5,611	5,588	23	2,218	2,209	9	293	293	0
1967	5,439	5,411	28	2,225	2,204	21	307	306	1
1968	5,796	5,765	31	2,435	2,418	17	368	368	0
1969	6,282	6,235	47	2,426	2,406	20	364	363	1
1970	6,800	6,747	53	2,503	2,473	30	366	365	1
1971	6,939	6,879	60	2,700	2,656	44	427	426	1
1972	7,258	7,181	77	2,869	2,821	48	437	435	2
1973	8,013	7,924	89	3,195	3,135	60	435	426	9
1974	8,633	8,488	145	3,247	3,164	83	390	387	3
1975	8,289	8,116	173	3,268	3,161	107	361	356	5
1976	8,493	8,214	279	3,605	3,454	151	388	382	6
1977	8,898	8,413	485	3,606	3,421	185	336	328	8
1978	9,900	9,141	759	3,226	3,030	196	303	295	8
1979	10,583	9,534	1,049	3,165	2,951	214	302	298	4
1980	11,046	9,959	1,087	3,198	2,933	265	306	295	11
1981	11,331	10,100	1,231	3,428	3,112	316	358	348	10
1982	11,280	9,962	1,318	3,456	3,104	352	368	351	17
1983	10,747	9,263	1,484	3,504	3,122	382	397	384	13
1984	10,351	8,928	1,423	3,551	3,136	415	407	382	25
1985	9,730	8,388	1,342	3,542	3,128	414	391	371	20
1986	9,223	7,994	1,229	3,281	2,908	373	429	408	21
1987	8,746	7,550	1,196	3,267	2,792	475	477	459	18
1988	8,131	6,960	1,171	3,134	2,721	413	531	501	30
1989	8,015	6,841	1,174	3,296	2,851	445	538	484	54
1990	7,992	6,730	1,262	3,213	2,693	520	553	504	49
1991	8,083	6,803	1,280	3,404	2,864	540	575	529	41
1992	8,920	7,395	1,525	3,755	3,120	635	594	535	50
1993	9,788	8,009	1,779	4,438	3,607	831	624	558	54
1994	10,603	8,619	1,984	4,918	3,965	953	683	598	80
1995	11,329	9,031	2,298	5,168	4,123	1,045	656	575	76
1996	12,053	9,629	2,424	5,002	3,938	1,064	698	616	79
1997	12,010	9,441	2,569	4,880	3,781	1,099	656	572	80
1998	11,522	8,946	2,576	4,736	3,582	1,154	650	544	100
1999	--	--	--	--	--	--	584	495	89
2000	9,596	7,263	2,333	4,140	3,065	1,075	555	465	88
2001	8,949	6,908	2,041	4,013	2,952	1,061	594	482	111

KEY: -- = Detailed national data were not released for the academic year ending 1999 by the National Center for Education Statistics.

NOTES: See section C for specific fields that are included in this field of study.

Details may not sum to totals because of missing information on gender for some recipients.

SOURCES: Tabulated by National Science Foundation/Division of Science Resources Statistics; data from Department of Education/National Center for Education Statistics: Integrated Postsecondary Education Data System Completions Survey; and NSF/SRS: Survey of Earned Doctorates

Table 46. Computer science degrees awarded, by degree level and sex of recipient: 1966-2001

Academic year ending	Bachelor's			Master's			Doctoral [1]		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
1966	89	76	13	238	221	17	19	19	0
1967	222	198	24	449	423	26	38	37	1
1968	459	404	55	548	518	30	36	36	0
1969	933	812	121	1,012	939	73	64	62	2
1970	1,544	1,345	199	1,459	1,324	135	107	105	2
1971	2,388	2,064	324	1,588	1,424	164	128	125	3
1972	3,402	2,941	461	1,977	1,752	225	167	155	12
1973	4,305	3,665	640	2,113	1,888	225	196	181	15
1974	4,757	3,977	780	2,276	1,983	293	198	189	9
1975	5,039	4,083	956	2,299	1,961	338	213	199	14
1976	5,664	4,540	1,124	2,603	2,226	377	244	221	23
1977	6,426	4,887	1,539	2,798	2,332	466	216	197	19
1978	7,224	5,360	1,864	3,038	2,471	567	196	181	15
1979	8,769	6,306	2,463	3,055	2,480	575	210	183	27
1980	11,213	7,814	3,399	3,647	2,883	764	218	197	21
1981	15,233	10,280	4,953	4,218	3,247	971	232	206	26
1982	20,431	13,316	7,115	4,935	3,625	1,310	220	200	20
1983	24,682	15,690	8,992	5,321	3,813	1,508	286	250	36
1984	32,435	20,369	12,066	6,190	4,379	1,811	295	258	37
1985	39,121	24,690	14,431	7,101	5,064	2,037	310	277	33
1986	42,195	27,069	15,126	8,070	5,658	2,412	399	351	48
1987	39,927	26,038	13,889	8,481	5,985	2,496	450	385	65
1988	34,896	23,543	11,353	9,166	6,702	2,464	515	459	56
1989	30,963	21,418	9,545	9,399	6,773	2,626	612	504	108
1990	27,695	19,321	8,374	9,643	6,968	2,675	705	595	110
1991	25,410	17,896	7,514	9,324	6,563	2,761	800	679	117
1992	24,958	17,748	7,210	9,655	6,980	2,675	869	747	120
1993	24,580	17,629	6,951	10,349	7,554	2,795	880	737	138
1994	24,553	17,533	7,020	10,546	7,817	2,729	903	762	137
1995	24,769	17,706	7,063	10,563	7,777	2,786	997	808	186
1996	24,545	17,773	6,772	10,613	7,763	2,850	920	775	139
1997	25,393	18,490	6,903	10,489	7,510	2,979	909	743	150
1998	27,674	20,235	7,439	11,752	8,338	3,414	927	765	159
1999	--	--	--	--	--	--	855	692	156
2000	37,388	26,914	10,474	14,529	9,661	4,868	859	716	141
2001	43,184	31,284	11,900	16,341	10,833	5,508	826	669	155

[1] In the Survey of Earned Doctorates, data on computer science were not collected separately from mathematics until 1978, and complete data on computer science are not available from the SED until 1979. Data shown for 1966 through 1978 are from the Completions Survey.

KEY: -- = Detailed national data were not released for the academic year ending 1999 by the National Center for Education Statistics.

NOTES: See section C for specific fields that are included in this field of study.

Details may not sum to totals because of missing information on gender for some recipients.

SOURCES: Tabulated by National Science Foundation/Division of Science Resources Statistics; data from Department of Education/National Center for Education Statistics: Integrated Postsecondary Education Data System Completions Survey; and NSF/SRS: Survey of Earned Doctorates

Table 40. Earth, atmospheric, and oceanographic science degrees awarded, by degree level and sex of recipient: 1966-2001

Academic year ending	Bachelor's			Master's			Doctoral		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
1966	1,712	1,551	161	759	714	45	404	392	12
1967	1,936	1,739	197	971	916	55	415	409	6
1968	2,339	2,105	234	1,008	937	71	434	423	11
1969	2,924	2,633	291	1,124	1,035	89	496	476	20
1970	3,351	3,008	343	1,124	999	125	498	483	15
1971	3,562	3,179	383	1,227	1,111	116	536	523	13
1972	4,055	3,560	495	1,408	1,256	152	598	576	22
1973	4,374	3,842	532	1,470	1,294	176	624	597	27
1974	4,823	4,055	768	1,679	1,482	197	615	581	34
1975	4,877	4,050	827	1,503	1,309	194	625	595	30
1976	5,046	4,124	922	1,581	1,361	220	641	579	62
1977	5,653	4,479	1,174	1,659	1,433	226	689	630	59
1978	6,003	4,709	1,294	1,832	1,542	290	621	560	61
1979	6,082	4,695	1,387	1,777	1,467	310	642	584	58
1980	6,155	4,693	1,462	1,793	1,457	336	628	564	64
1981	6,694	5,028	1,666	1,876	1,470	406	583	527	56
1982	7,061	5,254	1,807	2,012	1,560	452	657	554	103
1983	7,298	5,450	1,848	1,959	1,515	444	624	529	95
1984	7,925	5,991	1,934	1,982	1,517	465	608	502	106
1985	7,576	5,715	1,861	2,160	1,639	521	599	491	108
1986	6,076	4,722	1,354	2,234	1,717	517	559	464	95
1987	4,689	3,629	1,060	2,051	1,531	520	602	490	112
1988	3,554	2,707	847	1,920	1,433	487	695	560	135
1989	3,181	2,380	801	1,819	1,337	482	723	575	148
1990	2,776	2,001	775	1,596	1,218	378	738	597	141
1991	2,728	1,946	782	1,499	1,116	383	815	631	179
1992	3,201	2,177	1,024	1,425	1,057	368	794	600	188
1993	3,503	2,453	1,050	1,397	1,006	391	771	602	160
1994	3,868	2,665	1,203	1,418	994	424	824	635	183
1995	4,478	2,954	1,524	1,483	1,032	451	780	608	170
1996	4,457	2,972	1,485	1,487	1,051	436	794	614	172
1997	4,466	2,924	1,542	1,435	948	487	878	663	209
1998	4,321	2,722	1,599	1,426	932	494	814	592	219
1999	--	--	--	--	--	--	805	591	210
2000	4,047	2,430	1,617	1,345	832	513	758	523	230
2001	3,968	2,346	1,622	1,363	799	564	748	511	236

KEY: -- = Detailed national data were not released for the academic year ending 1999 by the National Center for Education Statistics.

NOTES: See section C for specific fields that are included in this field of study.

Details may not sum to totals because of missing information on gender for some recipients.

SOURCES: Tabulated by National Science Foundation/Division of Science Resources Statistics; data from Department of Education/National Center for Education Statistics: Integrated Postsecondary Education Data System Completions Survey; and NSF/SRS: Survey of Earned Doctorates

Table 30. Electrical engineering degrees awarded, by degree level and sex of recipient: 1966-2001

Academic year ending	Bachelor's			Master's			Doctoral		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
1966	11,007	10,978	29	3,872	3,850	22	569	567	2
1967	10,843	10,801	42	3,953	3,942	11	675	675	0
1968	10,725	10,682	43	4,226	4,204	22	741	741	0
1969	11,695	11,629	66	4,033	4,011	22	829	826	3
1970	12,288	12,220	68	4,138	4,109	29	857	854	3
1971	12,288	12,212	76	4,282	4,252	30	862	858	4
1972	12,181	12,099	82	4,209	4,157	52	815	810	5
1973	12,377	12,219	158	3,899	3,850	49	787	780	7
1974	11,419	11,302	117	3,499	3,444	55	678	675	3
1975	10,246	10,116	130	3,471	3,413	58	714	698	16
1976	9,874	9,681	193	3,774	3,670	104	711	696	15
1977	10,018	9,750	268	3,788	3,654	134	667	646	21
1978	11,213	10,778	435	3,742	3,600	142	539	522	17
1979	12,440	11,781	659	3,596	3,453	143	611	600	11
1980	13,902	13,000	902	3,842	3,658	184	540	523	17
1981	15,040	13,940	1,100	3,902	3,681	221	549	527	22
1982	16,553	15,142	1,411	4,465	4,177	288	616	594	22
1983	19,205	17,283	1,922	4,819	4,484	335	625	612	13
1984	21,541	19,252	2,289	5,519	5,081	438	660	645	15
1985	23,668	20,936	2,732	5,649	5,154	495	716	681	35
1986	26,112	22,885	3,227	6,147	5,508	639	806	768	38
1987	26,791	23,227	3,564	6,895	6,178	717	779	747	32
1988	25,942	22,418	3,524	7,455	6,642	813	1,010	962	48
1989	24,318	21,130	3,188	7,849	6,933	916	1,137	1,070	67
1990	23,015	20,148	2,867	8,009	7,018	991	1,276	1,192	84
1991	21,520	18,757	2,763	7,942	7,008	934	1,405	1,312	79
1992	20,256	17,801	2,455	8,274	7,229	1,045	1,483	1,352	115
1993	19,598	17,339	2,259	8,828	7,777	1,051	1,543	1,403	125
1994	18,241	15,990	2,251	8,870	7,721	1,149	1,673	1,516	147
1995	17,579	15,409	2,170	8,743	7,539	1,204	1,731	1,545	173
1996	16,667	14,695	1,972	8,156	6,960	1,196	1,741	1,556	169
1997	16,434	14,416	2,018	7,341	6,197	1,144	1,721	1,561	150
1998	16,322	14,310	2,012	7,971	6,595	1,376	1,596	1,429	156
1999	--	--	--	--	--	--	1,478	1,310	155
2000	17,672	15,322	2,350	8,339	6,781	1,558	1,542	1,337	195
2001	18,371	15,829	2,542	8,630	6,957	1,673	1,576	1,373	202

KEY: -- = Detailed national data were not released for the academic year ending 1999 by the National Center for Education Statistics.

NOTES: See section C for specific fields that are included in this field of study.

Details may not sum to totals because of missing information on gender for some recipients.

SOURCES: Tabulated by National Science Foundation/Division of Science Resources Statistics; data from Department of Education/National Center for Education Statistics: Integrated Postsecondary Education Data System Completions Survey; and NSF/SRS: Survey of Earned Doctorates

Table 33. Materials/metallurgy engineering degrees awarded, by degree level and sex of recipient: 1966-2001

Academic year ending	Bachelor's			Master's			Doctoral		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
1966	792	785	7	400	397	3	211	209	2
1967	836	828	8	444	443	1	267	266	1
1968	881	863	18	460	458	2	215	213	2
1969	952	942	10	441	435	6	280	279	1
1970	977	967	10	429	423	6	303	302	1
1971	916	903	13	480	472	8	306	305	1
1972	909	893	16	524	513	11	294	291	3
1973	885	870	15	582	569	13	299	292	7
1974	821	789	32	521	508	13	280	277	3
1975	711	676	35	500	483	17	272	267	5
1976	704	661	43	475	447	28	252	244	8
1977	738	679	59	504	481	23	248	238	10
1978	835	728	107	506	468	38	247	242	5
1979	1,045	862	183	529	475	54	236	228	8
1980	1,303	1,076	227	598	539	59	273	259	14
1981	1,434	1,164	270	666	587	79	234	217	17
1982	1,696	1,372	324	632	560	72	255	238	17
1983	1,392	1,104	288	672	567	105	268	238	30
1984	1,355	1,033	322	726	605	121	271	245	26
1985	1,276	990	286	713	600	113	303	271	32
1986	1,259	924	335	810	673	137	305	281	24
1987	1,152	854	298	765	600	165	392	347	45
1988	1,211	891	320	749	597	152	374	341	33
1989	1,114	853	261	815	634	181	380	335	45
1990	1,166	895	271	802	650	152	440	391	49
1991	1,166	912	254	787	607	180	489	412	77
1992	1,091	846	245	796	653	143	485	416	61
1993	1,216	956	260	849	682	167	535	449	78
1994	1,106	866	240	910	723	187	539	452	83
1995	1,046	799	247	852	668	184	588	489	95
1996	1,004	781	223	774	599	175	574	483	84
1997	1,063	804	259	724	550	174	582	470	106
1998	1,007	772	235	698	528	170	565	477	84
1999	--	--	--	--	--	--	469	376	88
2000	972	704	268	759	558	201	451	367	83
2001	930	667	263	709	536	173	497	392	105

KEY: -- = Detailed national data were not released for the academic year ending 1999 by the National Center for Education Statistics.

NOTES: See section C for specific fields that are included in this field of study.

Details may not sum to totals because of missing information on gender for some recipients.

SOURCES: Tabulated by National Science Foundation/Division of Science Resources Statistics; data from Department of Education/National Center for Education Statistics: Integrated Postsecondary Education Data System Completions Survey; and NSF/SRS: Survey of Earned Doctorates

Table 45. Mathematics degrees awarded, by degree level and sex of recipient: 1966-2001

Academic year ending	Bachelor's			Master's			Doctoral		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
1966	20,090	13,401	6,689	4,772	3,771	1,001	769	722	47
1967	21,308	13,998	7,310	5,284	4,000	1,284	830	782	48
1968	23,625	14,839	8,786	5,533	4,202	1,331	971	924	47
1969	27,330	17,103	10,227	5,723	4,230	1,493	1,070	1,014	56
1970	27,565	17,248	10,317	5,648	3,974	1,674	1,225	1,148	77
1971	24,918	15,424	9,494	5,201	3,677	1,524	1,238	1,142	96
1972	23,848	14,525	9,323	5,209	3,657	1,552	1,281	1,185	96
1973	23,223	13,878	9,345	5,033	3,528	1,505	1,232	1,113	119
1974	21,813	12,874	8,939	4,840	3,340	1,500	1,211	1,096	115
1975	18,346	10,646	7,700	4,338	2,910	1,428	1,147	1,038	109
1976	16,085	9,531	6,554	3,863	2,550	1,313	1,003	890	113
1977	14,303	8,354	5,949	3,698	2,398	1,300	933	811	122
1978	12,701	7,455	5,246	3,383	2,233	1,150	838	718	120
1979	11,901	6,943	4,958	3,046	1,989	1,057	769	650	119
1980	11,473	6,625	4,848	2,868	1,832	1,036	744	649	95
1981	11,173	6,392	4,781	2,569	1,692	877	728	616	112
1982	11,708	6,650	5,058	2,731	1,821	910	720	624	96
1983	12,662	7,112	5,550	2,856	1,871	985	701	588	113
1984	13,511	7,524	5,987	2,770	1,806	964	698	583	115
1985	15,389	8,295	7,094	2,903	1,887	1,016	688	582	106
1986	16,531	8,851	7,680	3,184	2,066	1,118	729	608	121
1987	16,515	8,833	7,682	3,327	2,026	1,301	740	615	125
1988	15,981	8,569	7,412	3,434	2,057	1,377	749	628	121
1989	15,314	8,264	7,050	3,430	2,060	1,370	859	704	155
1990	14,674	7,863	6,811	3,684	2,208	1,476	892	734	158
1991	14,784	7,804	6,980	3,632	2,146	1,486	1,038	835	199
1992	14,931	7,945	6,986	3,665	2,219	1,446	1,058	841	205
1993	14,853	7,854	6,999	3,751	2,219	1,532	1,146	865	264
1994	14,632	7,864	6,768	3,804	2,311	1,493	1,118	879	236
1995	13,851	7,360	6,491	3,932	2,353	1,579	1,190	919	265
1996	13,076	7,084	5,992	3,742	2,236	1,506	1,122	881	231
1997	12,723	6,834	5,889	3,599	2,110	1,489	1,123	851	263
1998	12,094	6,435	5,659	3,525	2,055	1,470	1,177	872	297
1999	--	--	--	--	--	--	1,083	803	277
2000	11,735	6,131	5,604	3,295	1,797	1,498	1,050	790	259
2001	11,455	5,958	5,497	3,280	1,891	1,389	1,007	731	276

KEY: -- = Detailed national data were not released for the academic year ending 1999 by the National Center for Education Statistics.

NOTES: See section C for specific fields that are included in this field of study.

Details may not sum to totals because of missing information on gender for some recipients.

SOURCES: Tabulated by National Science Foundation/Division of Science Resources Statistics; data from Department of Education/National Center for Education Statistics: Integrated Postsecondary Education Data System Completions Survey; and NSF/SRS: Survey of Earned Doctorates

Table 32. Mechanical engineering degrees awarded, by degree level and sex of recipient: 1966-2001

Academic year ending	Bachelor's			Master's			Doctoral		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
1966	7,811	7,792	19	2,154	2,147	7	457	456	1
1967	7,890	7,870	20	2,176	2,169	7	537	535	2
1968	7,930	7,898	32	2,136	2,130	6	597	595	2
1969	8,514	8,474	40	2,299	2,295	4	646	646	0
1970	9,310	9,271	39	2,298	2,286	12	635	633	2
1971	9,177	9,134	43	2,502	2,495	7	611	611	0
1972	8,784	8,735	49	2,552	2,527	25	616	614	2
1973	8,795	8,732	63	2,396	2,374	22	541	534	7
1974	7,883	7,817	66	2,058	2,031	27	544	537	7
1975	7,089	7,005	84	2,032	2,012	20	487	483	4
1976	6,984	6,834	150	2,088	2,056	32	417	413	4
1977	7,927	7,685	242	2,094	2,039	55	372	366	6
1978	9,100	8,628	472	2,095	2,029	66	377	374	3
1979	10,360	9,740	620	2,012	1,939	73	366	361	5
1980	12,020	11,127	893	2,194	2,087	107	384	377	7
1981	13,573	12,422	1,151	2,419	2,292	127	360	354	6
1982	14,315	13,049	1,266	2,539	2,388	151	437	420	17
1983	16,031	14,546	1,485	2,683	2,517	166	379	371	8
1984	17,040	15,228	1,812	2,964	2,765	199	427	412	15
1985	17,200	15,399	1,801	3,272	3,044	228	513	487	26
1986	16,586	14,876	1,710	3,256	3,002	254	536	518	18
1987	15,723	13,996	1,727	3,380	3,133	247	657	640	17
1988	15,331	13,567	1,764	3,513	3,218	295	715	686	29
1989	15,217	13,537	1,680	3,703	3,377	326	760	731	29
1990	14,693	12,978	1,715	3,630	3,276	354	884	846	38
1991	14,263	12,673	1,590	3,680	3,320	360	875	810	57
1992	14,352	12,791	1,561	3,826	3,455	371	987	933	45
1993	14,708	13,076	1,632	4,169	3,769	400	1,030	955	57
1994	15,297	13,554	1,743	4,277	3,860	417	1,015	940	69
1995	15,141	13,441	1,700	4,368	3,918	450	1,025	954	64
1996	14,509	12,773	1,736	4,009	3,555	454	1,052	963	78
1997	13,806	12,171	1,635	3,756	3,337	419	1,023	929	88
1998	13,363	11,727	1,636	3,551	3,090	461	1,023	923	93
1999	--	--	--	--	--	--	855	751	96
2000	13,109	11,325	1,784	3,378	2,923	455	863	766	96
2001	13,160	11,421	1,739	3,472	3,024	448	953	860	91

KEY: -- = Detailed national data were not released for the academic year ending 1999 by the National Center for Education Statistics.

NOTES: See section C for specific fields that are included in this field of study.

Details may not sum to totals because of missing information on gender for some recipients.

SOURCES: Tabulated by National Science Foundation/Division of Science Resources Statistics; data from Department of Education/National Center for Education Statistics: Integrated Postsecondary Education Data System Completions Survey; and NSF/SRS: Survey of Earned Doctorates

Table 38. Physics degrees awarded, by degree level and sex of recipient: 1966-2001

Academic year ending	Bachelor's			Master's			Doctoral		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
1966	4,608	4,384	224	1,949	1,869	80	995	976	19
1967	4,733	4,466	267	2,111	2,015	96	1,248	1,216	32
1968	5,045	4,749	296	2,088	1,993	95	1,338	1,313	25
1969	5,535	5,213	322	2,259	2,139	120	1,349	1,317	32
1970	5,333	5,004	329	2,205	2,047	158	1,544	1,507	37
1971	5,076	4,733	343	2,194	2,042	152	1,625	1,577	48
1972	4,645	4,322	323	2,035	1,876	159	1,505	1,467	38
1973	4,268	3,955	313	1,755	1,642	113	1,458	1,408	50
1974	3,962	3,625	337	1,662	1,526	136	1,206	1,155	51
1975	3,716	3,354	362	1,577	1,453	124	1,169	1,111	58
1976	3,544	3,156	388	1,451	1,319	132	1,087	1,043	44
1977	3,420	3,062	358	1,319	1,193	126	1,030	975	55
1978	3,330	2,961	369	1,294	1,171	123	929	884	45
1979	3,338	2,939	399	1,319	1,184	135	993	928	65
1980	3,397	2,963	434	1,192	1,074	118	862	808	54
1981	3,441	3,009	432	1,294	1,179	115	906	844	62
1982	3,475	3,014	461	1,284	1,128	156	912	844	68
1983	3,800	3,317	483	1,370	1,208	162	928	869	59
1984	3,921	3,361	560	1,535	1,341	194	982	915	67
1985	4,111	3,550	561	1,523	1,333	190	980	889	91
1986	4,189	3,578	611	1,501	1,277	224	1,078	978	100
1987	4,324	3,629	695	1,543	1,300	243	1,137	1,030	107
1988	4,103	3,492	611	1,681	1,428	253	1,172	1,058	114
1989	4,347	3,705	642	1,739	1,448	291	1,161	1,060	101
1990	4,193	3,514	679	1,819	1,523	296	1,265	1,135	130
1991	4,245	3,575	670	1,725	1,441	284	1,286	1,137	142
1992	4,107	3,435	672	1,834	1,539	295	1,403	1,226	167
1993	4,080	3,403	677	1,781	1,463	318	1,399	1,216	169
1994	4,005	3,295	710	1,952	1,655	297	1,548	1,364	175
1995	3,836	3,161	675	1,826	1,535	291	1,479	1,291	182
1996	3,703	3,019	684	1,686	1,385	301	1,485	1,283	193
1997	3,393	2,741	652	1,497	1,242	255	1,401	1,196	193
1998	3,455	2,789	666	1,401	1,146	255	1,378	1,195	177
1999	--	--	--	--	--	--	1,271	1,103	160
2000	3,362	2,638	724	1,244	1,000	244	1,204	1,040	163
2001	3,457	2,701	756	1,376	1,090	286	1,192	1,036	155

KEY: -- = Detailed national data were not released for the academic year ending 1999 by the National Center for Education Statistics.

NOTES: See section C for specific fields that are included in this field of study.

Details may not sum to totals because of missing information on gender for some recipients.

SOURCES: Tabulated by National Science Foundation/Division of Science Resources Statistics; data from Department of Education/National Center for Education Statistics: Integrated Postsecondary Education Data System Completions Survey; and NSF/SRS: Survey of Earned Doctorates

Appendix C: Numbers from John Miller:

150 sq feet office space/ faculty member

250 people for admin and support

20 sq feet classroom space/ student in the class

1000 sq feet lab space/ faculty member

6:10 assignable sq feet to actual square feet ratio

1400 sq feet lab space/ 24 students