North Central Association of Colleges and Schools (NCA)

Self Study Report of the

College of Engineering and Applied Science

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i. Executive Summary

The College of Engineering and Applied Science is a national leader in engineering education reform with its activities in the Integrated Teaching and Learning Laboratory and the new Discovery Learning Initiative. At the same time the College is in the top ten of public engineering institutions in research dollars per faculty member. These two characteristics - deep commitment to undergraduate education and a world class research activity define the range, breadth and depth of our activities.

Our mission, academic goals and organization are presented in the report along with a number of quality measures. Highlighting our S.W.O.T. section (Strengths, Weaknesses, Opportunities and Threats): Our strength lies in our faculty, staff and students whose extraordinary devotion and exceptional hard work have taken us to an enviable position. Our opportunities are the development of research centers across disciplines and the vertical integration of our research activities with the undergraduate program through the Discovery Learning Initiative. Our weaknesses and threats are one in the same - funding. The College expenditures are less than 10% supported by the State. The rest is tuition, research and donations. While this is a measure of our success it also points to an unstable base of operations. This, in turn, forces us to spend a great deal of time on fundraising from governmental, corporate and individual sources, which, in turn, takes time and attention from teaching and research.

I. Description

A. Goals and Purposes

The College of Engineering and Applied Science actively supports the Mission Statement of the University of Colorado, Boulder Campus.

The goals of this College are to:

- ❑ attract and graduate excellent students of diverse demographics, providing them with an education which prepares them for success and future leadership in the engineering profession;
- ❑ be one of the foremost institutions of research, advancing the frontiers of knowledge for the benefit of society;
- ❑ be a nationally recognized leader in the evolving paradigm of engineering education, integrating teaching, learning, and discovery learning at the undergraduate and graduate levels;
- ❑ provide academic support to all of our students;
- ❑ achieve a recognized level of excellence in all degree programs; and,
- ❑ conduct outreach activities to support our enrollment goals, demands for continuing education and lifelong learning, and to support the educational needs of the citizens of the State of Colorado.

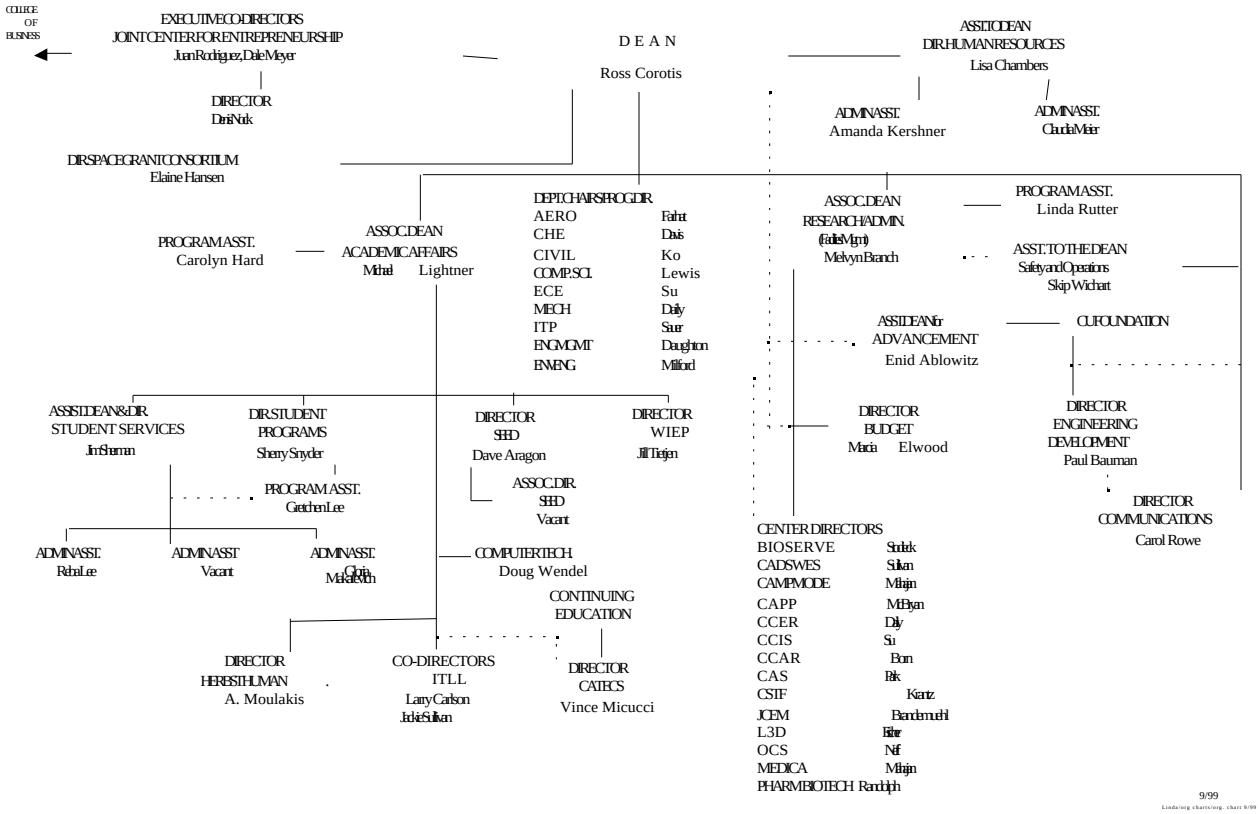
This College strives to graduate technically proficient men and women who have a diverse, global outlook on life, who realize that learning is a lifelong endeavor, and who appreciate their potential to benefit humanity and to protect our environment.

The College, Department and Programs maintain extensive websites. The College web address is http://www.colorado.edu/engineering/overview.htm

B. Organizational Structure

The organizational structure of the College of Engineering and Applied Science flows from the Dean to the Associate Deans, Departmental Chairs and select Program Directors. Unless otherwise indicated, Assistant Deans, Center Directors and other Program Directors report to an Associate Dean; faculty reports to their Department Chairs or Center Directors. Remaining faculty and staff report in accordance with the attached College organizational chart. The organizational chart for the College of Engineering and Applied Science is given below; a current copy is also available at this web address: http://www.colorado.edu/engineering/orgchart.htm

COLLEGE OF ENGINEERING & APPLIED SCIENCE



C. Brief Description of Programs

The Bachelors, Masters and Doctor of Philosophy degree programs offered by this College are summarized in the following table:

Table 1. Academic Degree Offerings of the College of Engineering and Applied Science

Academic Degree Departments/Programs	Bachelors	Masters	Doctorate
Aerospace Engineering Sciences (ABET)	BS*	ME/MS*	Ph.D.
Applied Mathematics	BS		
Architectural Engineering (ABET)	BS**		
Chemical Engineering (ABET)	BS*	ME/MS*	Ph.D.
Civil and Environmental Engineering (ABET)	BS*	ME/MS*/**	Ph.D.
Computer Science	BS*	ME/MS*	Ph.D.
Electrical Engineering (ABET)	BS*	ME/MS*	Ph.D.
Electrical and Computer Engineering (ABET)	BS		
Engineering Management		ME	
Engineering Physics	BS		
Environmental Engineering	BS		
Mechanical Engineering (ABET)	BS*	ME/MS*	Ph.D.
Telecommunications		ME/MS	
Minor programs are available in Applied Mathematics (BS), Computer Science (BS), and Mechanical Engineering (BS).			

Explanation of Terms:	
(ABET)	Indicates Bachelors degree programs with ABET accreditation
BS	Bachelor of Science degree
ME	Master of Engineering degree
MS	Master of Science degree
Ph.D.	Doctor of Philosophy degree
*	Degrees with combined Bachelor and Master degree options
**	Combined degree BS Architectural Engr. and MS Civil Engr.

The following degree options may also be noted on Internal Transcripts:

Degree	Option
Chemical Engineering	Computer, Environmental, Materials, Pre-medicine and Bioengineering
Electrical Engineering	Biomedical Engineering
Electrical & Computer Engr.	Biomedical Engineering
Mechanical Engineering	Environmental

Select engineering graduate courses are available for external completion through the Division of Continuing Education and the Center for Advanced Training in Engineering and Computer Science (CATECS). Degree programs possible through external courses are: Aerospace Engineering Sciences (ME/MS); Computer Science (ME); Electrical Engineering (ME/MS); Engineering Management (ME); and, Telecommunications (ME/MS).

Select courses are also available in Civil and Environmental Engineering, Environmental Engineering, and Mechanical Engineering.

To illustrate the diversity of academic interest demonstrated by engineering students, during the 1999 Fall Semester, of the 2566 undergraduate students in the College of Engineering: 132 students were seeking more than one degree (32 with double degrees in engineering); 29 from Music; 19 from Business; 51 from Arts and Sciences; and, 1 from Architecture and Planning.

Academic Departments and Programs

- **Aerospace Engineering Science** prepares engineers for an industry that encompasses the design and construction of commercial and military aircraft and space vehicles.
  Web address: http://aerospace.colorado.edu

- **Applied Mathematics** prepares graduates to mathematically model and solve practical problems. Applied mathematics is at the core of many disciplines ranging from engineering and science to business and economics.
  Web address: http://amath-www.colorado.edu/appm/

- **Architectural Engineering** prepares engineers for careers in the building industry and for research on building-related topics.
  Web address: http://civil.colorado.edu/Undergraduate_Advising/Architectural.html

- **Chemical Engineering** prepares engineers for careers that convert natural resources into industrial and consumer products using a wide variety of processing techniques.
  Web address: http://spot.colorado.edu/~chemeng/Home.html

- **Civil and Environmental Engineering** prepares engineers for the design and construction of structures, transportation systems, in the transmission of water and

control of rivers, in the development of water resources, land reclamation, work in the construction industry, and with problems in the physical environment. Web address: http://civil.colorado.edu

- **Computer Science** prepares graduates to work in the fields of programming languages, artificial intelligence, human-computer interaction, software engineering, operating systems, parallel processing, numerical analysis, database systems, and the theory of computation. Web address: http://www.cs.colorado.edu/

- **Electrical Engineering** prepares engineers to design and advance new electrical or electronic systems, devices, instruments or products. Engineering graduates of **Electrical and Computer Engineering** work in the field of computer engineering, advancing computer hardware design and the construction of efficient software systems. Web address: http://ece-www.colorado.edu

- **Engineering Management** graduates are prepared to enter the career field as broad-based technical managers with specialized knowledge in project management, finance and accounting, quality and productivity, process management, leadership and management. Web address: http://www.colorado.edu/EngMgmtProg/

- **Engineering Physics** graduates work in the diverse field of physics and have the knowledge required for work with industrial problems that can not be solved by standard procedures in highly specialized fields. Web address: http://physics.colorado.edu/

- **Environmental Engineering** prepares graduates to maintain the quality of human environmental systems and the natural environment. Environmental engineers develop engineering solutions to solve environmental problems impacting the quality of the biosphere, land, water and air. Web address is currently under development.

- **Mechanical Engineering** prepares engineers for careers in a variety of industrial sectors including transportation, energy, electronics manufacturing, engineering management, medical and environmental product manufacturing. Web address: http://me-www.colorado.edu

- **Telecommunications** graduates are interdisciplinary and are prepared to work in the career fields of telecommunication technology, telecommunications policy, along with the development, planning and management of telecommunications systems. Web address: http://itp-www.colorado.edu/main.html

Student Services, Programs and Academic Support

The College of Engineering and Applied Science also has a variety of academic and academic support programs that do not lead to degrees, but enhance the student's educational experience and assist the student in completing a rigorous field of study. At the undergraduate level, information on many of these programs is found at the following web address: http://www.colorado.edu/engineeering/student_progs.htm#services A brief summary of these student support programs is provided below.

- **Career Services** and internship coordination is provided by a professional staff member from the office of Career Services. This staff member works half time in the Dean's Office to assist students with coordinating internships, co-op programs, answering career questions, informing students of career opportunities, and may assist with Career Fair programs. Web address: http://www.colorado.edu/career services/

- **The Colorado Engineer** is a student produced magazine, published each semester and in the summer, that highlights student academic events, topics of student interest and professional activities in the College. This magazine is the oldest student publication at the University of Colorado, Boulder. Web address: http://www.colorado.edu/engineering/ColoradoEngineer

- The **Colorado Space Grant College** is a NASA program that provides opportunities for students from all engineering and science disciplines to participate in space related research activities, seminars and courses. Web address: http://www-sgc.colorado.edu

- **Engineering 2001** was first taught during the Fall Semester 1998 with the objective of assisting new students in their academic adjustment to this College. Topics covered in this non-credit program include: time management, study skills, learning strategies, how to prepare for hourly and final examinations, and information on Boulder Campus academic support services. Web address: http://www.colorado.edu/engineering/eng2001.htm

- **Engineering Peer Advocates** are undergraduate students who offer a variety of direct services to the College, including student advising, assistance in selecting a major, maintaining a test file, tutoring, and assisting the College with outreach efforts.

- The **Engineering Quad** is a cooperative residential program between the College, the Department of Housing, the College of Arts and Sciences, and the Council on Academic Programs in the Residence Halls. Engineering students may elect to be housed in one of the four residential buildings adjacent to the Engineering Center. These buildings feature an academic support residential program that includes an engineering configured computer

laboratory, specialized tutoring, opportunities for Engineering faculty and staff contact, calculus work groups, and other supportive academic and non-academic residential programs.

- **Engineering Student Ambassadors** are undergraduate and graduate student volunteers who are student representatives of the College. They offer a student's view of the College to prospective students and their parents, assist with visitation programs, conduct tours of the Engineering Center, and assist in hosting College orientation programs and alumni functions. Web address: http://ucsub.colorado.edu/~ea

- **Engineering Student Organizations** are represented by the University of Colorado Engineering Council (UCEC), a student government body for the College. UCEC represents 29 student professional and honorary societies and interested engineering students. Included in this group is the student committee administering the Engineering Excellence Fund. A listing of student organizations is found at the following web address: http://www.colorado.edu/engineering/student_progs.htm

- **Financial Aid Assistance** for all students is available through a cooperative program between the College and the Office of Financial Aid. One staff member from Financial Aid works in the College half time to advise and assist students with questions and problems relating to loans, grants, scholarships and unique financial circumstances. This staff member also works with the College Undergraduate Scholarship Committee to ensure that our students have access to the financial resources necessary to complete their degrees.

- The **Herbst Program of Humanities** is named after Clarence Herbst, Jr. and is a unique program with the objective of providing engineering students with the opportunity to expand their non-technical education through the study of humanities.

- The **Integrated Teaching and Learning Laboratory (ITLL)** supports a fundamental change in engineering education. Instruction in ITLL is interdisciplinary and is based upon the application of theoretical, mathematical and scientific principles to solve basic human problems. Interdisciplinary student teams work under faculty guidance on design projects from the freshman through the senior year. Web address: http://civil.colorado.edu/~itl

- The **Success in Engineering through Excellence and Diversity Program (SEED),** formerly the Minority Engineering Program (MEP), recently celebrated 25 years of operation. This Program seeks to increase the number of underrepresented students who graduate from the College with undergraduate engineering degrees. This Program is active in recruitment, securing scholarships, integrating students into the University, tutoring, counseling, and in providing support programs to their students. Web address: http://www.colorado.edu/engineering/MEP/

- ❑ The **Open Option Program** is a non-degree option in which new freshmen may elect not to select a specific engineering major during their freshman year, but remain with an undeclared degree option. With careful advising, these freshmen preserve the Four-Year Graduation Guarantee and take a slightly revised curriculum of study that assists them in selecting an engineering major. Advising is by professional staff in the Engineering Dean's Office.
  Web address: http://www.colorado.edu/engineering//General/open_option.htm

- ❑ The **Women in Engineering Program (WIEP)** conducts recruiting, retention, and outreach activities to increase the number of women enrolled in this College, improve their academic experience, and promote their retention. WIEP assists in the recruitment of women, securing appropriate scholarships, providing timely academic support services, mentoring and counseling.
  Web address: http://www.colorado.edu/engineering/WIEP

II. Self Study

A. Evidence of Quality

1. Internal and External Assessments

Assessment is an on-going process within the profession of engineering; consequently, assessment and process improvement activities are integral to the academic affairs of this College. The faculty frequently evaluate their students, their instruction, the direction of their research, and their service activities. Departments likewise frequently assess their faculty, examining their curriculums, the demands of the engineering profession in various industries, and the service conducted by faculty. The Dean and Associate Deans, along with other internal and external bodies, then provide on-going guidance and assessment to the Departments, Research Centers, and Programs of this College.

Internal assessments include an annual faculty performance review. This review is begun with a report by each faculty member on his/her professional activities for the year. This report is evaluated within each department and program and faculty are assigned a rating from 1 (lowest) to 4 (highest) in the areas of teaching, research and service. A differential work load is allowed within the College in which the faculty, with their chairs, can set a work load at variance with the standard 40% teaching, 40% research and 20% service. The reported ratings are reviewed at the College level for uniformity and each faculty is assigned an overall rating. This provides a College wide ranking for each faculty member that is used to assign raises, identify areas for improvement and maintain a continuous evaluation of faculty activities. Information on the procedure for the evaluation of faculty is found in the Rules and Approved Recommendations of Policy of the College of Engineering and Applied Science and in supplemental memorandums from the Dean of the College and Departmental Chairs.

This College offers annual faculty awards for outstanding teaching, research, service, advising, and innovation in teaching.

Faculty members are also provided a student assessment of their courses through use of a Faculty Course Questionnaire (FCQ), with the results published each semester. Other assessments are secured through internal and external reviews and peer comments at the time of promotion or whenever deemed necessary by the Chair. The College is an enthusiastic user of the services provided by the Faculty Teaching Excellence Program and the Graduate Teacher Program. We provide orientation for all new Teaching Assistants and faculty.

Teaching assistants are also evaluated by use of the FCQ and faculty comments, and their continued appointments are contingent upon satisfactory performance. Recent FCQ results are at the following web address: http://www.colorado.edu/pba/fcq/

External reviews of faculty research are made by peers whenever grant proposals are submitted or manuscripts are submitted for publication in professional publications. The faculty of this College have been highly successful in securing external research grants, as demonstrated by research now providing fifty-five percent of the funds brought into this College. The total research expenditures place us among the top ten public universities in research per faculty member. (The faculty performance in research publications, funding and awards is given elsewhere in this report.)

All Academic Departments and Programs have external Advisory Boards that provide input into their educational efforts and provide an external perspective on their curriculum and the success of their graduates in the professional workplace. The College utilizes an external Engineering Advisory Council (EAC) that is composed of 30 leaders from industry, government and academia who provide the College with guidance, support, and an external perspective on our current and proposed academic programs and the capabilities of our recent graduates in the profession of engineering.

An essential assessment of this College is provided at the undergraduate level by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET). During the Fall Semester of 1999 this College had an accreditation review visit by the Accreditation Commission. In 1993 this College was noted as having a "pace setting leadership in strategic planning," and commended the College for making undergraduate engineering its "first priority." ABET also recognized the innovative efforts of the College in involving the Engineering Development Council (since renamed the EAC), utilization of an Undergraduate Excellence Fund (since renamed the Engineering Excellence Fund), and the "pioneering concept and plan" for an Integrated Teaching Laboratory.

All evaluation processes rely upon a combination of internal and external subjective judgments and the assessment of measurable data where available and appropriate. We realize that external evaluations and comments tend to bring greater public attention and possible funding opportunities. Examples of public evaluations include annual U.S. News and World Reports articles on Undergraduate and Graduate programs in Engineering, annual reports by the American Association of Universities (AAU) and the National Research Council. Information on these rankings is available at the following web address: http://www.colorado.edu/ enginering/CUT96/ranks/html. For more information on rankings see the section on evaluation of unit.

Another external ranking process that serves this College well is the overall ranking of our undergraduate programs. The Boeing Aircraft Company has presented this College with two awards for Excellence in Engineering Education and the recognition that comes from these awards has been very helpful in our recruiting efforts. Numerous pre-collegiate publications also note the excellence of our programs; student projects done in the ITLL have been featured on NBC news; several faculty have been featured on television specials; and the academic reputation of this College with secondary school teachers and counselors is very high. This reputation, along with our selective outreach programs, assists us in attracting the most highly qualified secondary school and transfer students.

Evidence of the overall academic quality of our undergraduate students is demonstrated by the low number of students placed on academic probation or suspension by the College. During the past ten years this College has averaged only 4.5 percent of our undergraduate students on academic probation and 2.7 percent academically suspended. In addition, many of our students go on to the highest quality graduate schools and perform as well as engineering graduates from the top ten engineering colleges in this nation. Another favorable indication is that our graduates are in high demand by engineering and technical companies throughout this nation, as demonstrated during recent Career Fair 1999, in which 190 companies recruited at CU-Boulder and 149 actively recruited engineering graduates.

2. Improvements or Changes Resulting from Evaluation

a. Undergraduate Education

One of the educational innovations of this College has been the establishment of an Undergraduate Engineering Excellence Fund (now expanded to include graduate students and renamed the Engineering Excellence Fund [EEF]). The students of this College, concerned with the lack of state funding for educational innovation imposed on themselves and their successors an additional semester fee. Undergraduate and graduate students in engineering pay an additional fee of $18 per engineering course;the total amount derived from this fee for 1999-2000 was $ 749,000. A student committee with faculty advisors known as the EEF Committee administers this fund. $350,000 each year is dedicated to the operations of the ITLL. Each year the students decide on their priorities for improvement and put out a request for proposals from faculty and students. In this past funding cycle over 80 proposals were received. Approved proposals are funded after required committee review. Successful programs may be funded for more than one year all proposal are part of the College educational improvement effort. This has been a very successful student and faculty collaborative effort;

this Committee was the first to validate and fund the integrated teaching and learning concept that led to the ITLL.

As noted above, a significant educational innovation that came out of student and faculty desires for change is the Integrated Teaching and Learning Laboratory experience. This unique facility, the source of considerable interest and acclaim across the nation, has allowed our curriculum to expand in the direction of hands-on, collaborative, design-based active learning. Perhaps the most important change has been the development of a freshman design course that is offered in the ITLL. This laboratory course introduces freshman to engineering, engineering communication skills, the design process, basic use of tools and facilities, and develops team skills. We currently offer 16 sections of this course per year with approximately 70% of our students choosing this elective.

Other changes include extensive revisions to the undergraduate curriculums in Aerospace Engineering, Electrical Engineering, and Electrical and Computer Engineering. And, after several years of faculty discussion, we have established a new undergraduate degree program in Environmental Engineering in response to faculty and student requests for this interdisciplinary program.

b. Graduate Education

Graduate education is a key activity of the College. As a major research university we provide a superb venue in which to pursue advanced study and research in engineering. The requirements for the different degrees are listed on the departmental websites. While there are a number of Masters degree offerings the focus of the graduate activity in the College is the Ph.D. program. There is a growing interest in serving the professional and continuing education community through certificate programs and access mechanisms such as CATECS. However, it is clear that the degree programs and course offerings are associated with the research interests of the faculty and are meant to provide students with the intellectual background necessary to pursue state-of-the-art research in areas associated with faculty interests.

The student, peer, and external evaluation and assessment mechanisms mentioned in the undergraduate program are consistently used for the graduate courses as well. A large percentage of our graduate students are supported in their educational goals as Teaching Assistants or Research Assistants. Every effort is made to incorporate our graduate students into the intellectual family of the College. It is clearly true that as they progress through their programs they become much more colleagues than subordinates.

Our graduate students are highly sought after by industry and academia. Their research is acknowledged through publications and grant awards. We also have

a large number of our graduate students winning prestigious competitive fellowships.

The organization of graduate education on this campus is through the Graduate School and the departments. The students apply to the departments and with department recommendation can be admitted into the Graduate School. While the students consider themselves members of the College of Engineering they are, in fact, members of departments and the Graduate School. Faculty also must be appointed to the Graduate School faculty and only courses taught by Graduate Faculty are counted for degree requirements. This is a somewhat awkward arrangement, but allows for an administrative structure that aims to provide a uniform standard across the campus. Our graduate degree offerings are listed in Table 1.

External evaluations and comments have led this College to develop and implement a distance learning process for graduate students through the Division of Continuing Education. This Center for Advanced Training in Engineering and Computer Science (CATECS) provides the means by which non-resident engineers can secure an advanced degree without being resident on the Boulder Campus. External evaluations have also assisted in the development of the graduate interdisciplinary degree program in Telecommunications. External and internal comments have also prompted this College to develop a combined Bachelor and Master degree program (BS/MS) to encourage our best undergraduate students to pursue a Master of Science degree beginning in their final year of undergraduate study.

c. Technology

As a College of Engineering, technology surrounds our students. We have a curriculum with a large laboratory component using discipline specific technology as well as more standard computing facilities. All students have email accounts and email is a widely used communication mechanism for the faculty, staff and students.

Most courses in the College now use web pages for basic administrative support. Many courses are pursuing innovative use of technology in multimedia presentations, interactive homework and laboratories, presentation technology used by faculty and students, use of mathematical and simulation software to augment courses and provide the ability to solve real world problems as well as using Java based programs to aid the educational goals. A simple example is the ITLL CD-ROMs. During the construction of the ITLL videos were made of every step. They have been placed on CD-ROM along with the design plans, construction schedules, budgets, etc. and are used in our construction management courses.

The College contributes, through EEF and discretionary funds, significant support to the computing and technological infrastructure of the College. We have a number of public computing labs (run primarily from student computing fees) and an even greater number of departmental labs where there is usually a mixture of computing equipment or other specialized hardware. In addition, the College has purchased portable computer projectors for all departments and provided additional ethernet connections in a number of classrooms.

Our goal throughout is to examine the appropriate use of technology to support the students' learning and not simply technology for its own sake. Of course, the different engineering disciplines require the use of specialized technology and this is an important part of preparing students for the engineering workplace. Nonetheless, it is substance and not gift wrapping which is our goal. The College continues to play a key role in the ATLAS program and other campus technology initiatives.

d. Diversity

This College has been a leader in the development of educational programs to support diversity among our students. The Success in Engineering Through Excellence and Diversity Program (SEED) and the Women in Engineering Program (WIEP) have greatly assisted this College in recruiting, supporting and retaining ethnic minority and women students. Aware that recent legal change may impact the way in which we have previously supported these students, this College is currently undertaking efforts to define its desired diversity components and the desired number of students to meet these goals. Within the past three years the College Undergraduate Scholarship Committee has revised the process of awarding merit scholarships so as to more effectively package its awards to diversity targeted students and all undergraduate students in this College. Graduate scholarships are awarded through the student's academic department or the Graduate School. Information on the scholarship award process for undergraduates is found at the following web address:
http://www.colorado.edu/engineering/General/scholarships.htm

3. Interaction with Campus Units and Activities

The College of Engineering and Applied Science has always been actively integrated with the academic and academic support activities of other Boulder Campus units and activities. Examples of Engineering faculty involvement include: Roland Rautenstraus, a former Civil Engineering faculty member, served as President of the University of Colorado; David Kassoy from Mechanical Engineering currently serves as the interim Vice President for Academic Affairs and Technology; Richard Harpel,former professional staff member, is the current

Associate Vice President for Academic Affairs and University Relations; Robert Schnabel, formerly Associate Dean and Chair of Computer Science, is the Associate Vice Chancellor for Academic and Campus Technology; Susan Avery, faculty member in Electrical and Computer Engineering, is Director of the Cooperative Institute for Research in Environmental Sciences; Michael Lightner, faculty member in Electrical and Computer Engineering, is Associate Dean for Academic Affairs, has chaired the system-wide faculty grievance committee for two years (several college faculty also served on this committee); and John Daily faculty member from Mechanical Engineering, was chair of the Boulder Faculty Assembly.

In addition, our faculty and administrators actively serve on a variety of Boulder Campus standing and special committees. Examples include: Jill Tietjen, Director of the Women in Engineering Program, and Sheryl Snyder, Director of Student Programs, serve as members of the Chancellor's Committee on Women; James Sherman, Assistant Dean, serves as Chair of the Council of Associate Deans; Prof. Lightner also serves on the Boulder Campus Planning Commission.

4. Faculty/Staff Professional Development

There are several forms of professional development which are common in the College. First, of course, the faculty, through their research activities, are constantly participating in professional development. The university offers a number of courses and seminars in areas ranging from financial planning to computer usage which faculty are encouraged to attend. These University activities are also open to staff and time is provided in staff schedules to take these professional development courses when approved by their supervisor.

The University offers free tuition for one course per semester to full time faculty and staff, and a number of people in the College take advantage of this opportunity.

The College participates with FTEP in workshops for teacher development and for helping faculty use technology in their teaching. We also offer workshops for beginning faculty and staff on the university system.

Finally, there are funds available through the Deans office for faculty and staff to attend conferences for professional development. These are especially useful for faculty in areas where they do not have grant support - for example, education reform.

B. Activities

1. Evaluation of Unit

The College of Engineering and Applied Science is recognized nationally as one of the best engineering institutions for teaching and research. The 1993 accreditation review of this College by the Accreditation Board for Engineering and Technology resulted in full accreditation of all engineering programs for 6 years, the maximum number of years allowed by this Board. In 1999, U. S. News and World Reports ranked this College 31st of all graduate schools of engineering in reputation by academics and by engineers and recruiters, and 19th among public engineering colleges. Also in 1995, the National Research Council ranked our Ph. D. program in Aerospace Engineering Science 13th in the nation, the Ph. D. program in Civil and Environmental Engineering 24th, and the Ph. D. program in Chemical Engineering 26th. Also, in 1999, U. S. News and World Reports ranked this College 31st among Ph. D. granting institutions and 31st among public engineering colleges. Also in 1996, the American Association of Universities (AAU) ranked this College sixth in the nation among public institutions in terms of research funding per faculty member. When undergraduate and graduate rankings are combined, this College is recognized as being one of the top dozen public universities in the nation.

2. Instruction-quality, assessment, outcomes and integration

a. Curriculum

The College of Engineering and Applied Science offers a challenging and innovative curriculum for its undergraduate students. The College does not have a general education component; however, students must complete the minimum preparation standards (MAPS) and the humanities and social sciences requirement. Minimum preparation standards for students entering the College are four years of math and English, three years of science and social studies, and two years of a foreign language. Students deficient in any these areas must complete them prior to graduation. The humanities and social sciences requirement specifies that students must complete a minimum of 18 credit hours of approved coursework in the humanities and social sciences. At least six of these credit hours must be at the 3000 or 4000 level, including an upper division writing course.

Graduate education within the College of Engineering and Applied Science is very specialized and is defined by the various departments. Departmental programs are noteworthy for their integration of experiment and theory. The number of national graduate research fellowship awards continues to increase yearly with the College average being 30. Nearly all students graduating with M.S., M.E., or Ph.D. degrees are placed in good positions in industry, government and academe. New initiatives within the College that will enhance graduate education are the B.S. and M.S. degree program, and the concurrent Discovery Learning Initiative, aimed at involving undergraduate and graduate students in research activities.

Undergraduate degree programs reflect the College's commitment to making undergraduate engineering its first priority. The first-year curriculum developed by faculty in various departments is unique because it includes coursework in the following areas: mathematics, laboratory sciences, computer science, humanities and social sciences, introduction to the engineering disciplines, and Engineering Projects (a design course). Faculty believe that undergraduate education is very important as evidenced by the number of faculty who teach undergraduate courses. Tenure track faculty teach approximately 97% of the undergraduate courses taught in the College. The philosophy of the Integrated Teaching and Learning Laboratory, which emphasizes hands-on, interdisciplinary, team-based learning, has been integrated throughout the curriculum. The College also provides academic support to all of our students through the following programs: Engineering 2001, the Engineering Quad, the Peer Advocate tutoring and academic support, Minority Engineering, Women in Engineering, and individual assistance through the Dean's office.

There are many undergraduate academic opportunities within the College of Engineering and Applied Science. Undergraduate students have an opportunity to take the first-year Engineering Projects course and senior design courses. Departments assist undergraduates who would like to be involved with faculty in research by offering independent study, paid research assistance positions, and encouraging students to be a part of the University's Undergraduate Research Program (UROP). Students who are interested in teaching opportunities can become an undergraduate teaching assistant or a tutor for the College. In addition, students may also serve on the Engineering Excellence Fund Committee which, with faculty guidance, makes decisions about funding innovative education projects within the College. The college also offers the Herbst Program of Humanities for students who are interested in examining in-depth literature, political science and philosophy.

b. Assessment of student learning

Assessment of student learning in first-year courses such as mathematics, laboratory sciences and computer science includes homework assignments, labs or projects, hourly examinations, and the final examination. In Calculus I (APPM

1350), an algebra assessment is given to all students enrolled in the course to determine whether they are algebraically ready for Calculus I. Humanities and social science course assessment is conducted by the faculty of the College of Arts and Science and the College of Engineering and Applied Science Herbst Program of Humanities. Assessment in the Engineering Projects course encompasses design reviews, presentations, group consensus feedback, individual writing assignments, learning style assessment, and peer reviewed journal writing. Introduction to the engineering discipline courses assess students' learning through class assignments, projects, journal writing and a final examination.

In undergraduate degree programs, performance assessment is used to evaluate student design projects in technical elective courses and the senior capstone design courses. This type of assessment allows students and professors to create a partnership to formulate the standards of performance, criteria of quality, and suggestions for improvement which are a part of a process-oriented form of testing and evaluation. Portfolio assessment is being used to assess student learning in the upper division Architectural Engineering studio courses and the sophomore Projects Course. As an outcome assessment measure, students in their senior year in architectural, civil, chemical, and mechanical engineering are required to take the Fundamentals of Engineering (FE) exam, a State Board administered national exam (formerly the EIT exam). Prior to 1997, all the engineering departments, as part of the state's outcome assessment, required this examination. Departments which do not require students to take the FE use capstone design projects and alumni and employer feedback for assessment.

Assessment in the Master's degree programs includes comprehensive examinations in the area of study and an oral examination based upon the thesis, if the thesis option is selected. Doctoral programs require students to take a preliminary examination to determine whether they are qualified to enter the program, a comprehensive examination at the end of their coursework, and a final oral examination based upon the dissertation.

Based upon the assessment of the First-Year Engineering Projects course (GEEN 1400), nearly 80% of the students who took this course during their first year have remained in engineering into their third year, compared to the College's 55% average. Students report that this demanding design course gives meaning to their physics and calculus courses and frequently cite it as their initial reason for selecting CU and their remaining in engineering.

As a result of the Calculus I algebra assessment, the Applied Math department designed a one credit hour workshop for Calculus I & II that reviews the course content using the instructional format of collaborative learning to improve the retention in these courses. Performance in calculus is the number one predictor of whether or not a student will be successful in the College.

Group feedback from students enrolled in senior capstone, design, and seminar courses indicated that students wanted more advising services. In response, the number of faculty advisors was also increased.

c. Teaching

Teaching evaluation for purposes of reappointment, promotion, or tenure review generally includes primary and secondary components. Primary evaluation components consist of Faculty Course Questionnaires (including numerical ratings and written comments), letters from undergraduate and graduate students who have taken courses from the faculty member being evaluated, letters from students who have been research advisees of the faculty member, internal or external review of teaching materials, class visitations by colleagues, a teaching statement by the faculty member discussing teaching contributions made to the department or the college, teaching publications, or participation in activities of the American Society of Engineering Education or professional societies of which the faculty member is a member. Secondary evaluation includes additional teaching contributions and outreach activities such as the College's High School Honors Institute and comments, observations, and opinions from students that are submitted to the dean, department chair, or advisors.

Teaching evaluation for purposes of annual review also include primary and secondary components. Primary evaluation components consist of the following: Faculty Course Questionnaires, contributions made to the department or to the college in curriculum or course innovations, teaching publications, and participation in ASEE activities. Secondary evaluation components include additional teaching contributions and outreach activities, comments, observations, and opinions from students submitted to the dean, department chair, or advisors, or a teaching statement by the faculty member discussing the contributions they have made to their department or to the College. A diverse group of metrics is used to evaluate teaching.

One productivity measure of the college is the number of student generated credit hours. Student credit hours generated for the 1998-1999 year for undergraduate courses are 70,675 and for graduate course are 15,348. Another measure is 82% of the College’s undergraduate and graduate courses are taught by regular faculty (tenured and tenure track; research faculty and full time instructors). Regular faculty also taught 3.68 courses in that year which includes undergraduate and graduate courses. This is a much higher teaching load than many of our comparison institutions and certainly higher than the research active science departments on campus.

Annual faculty reviews are conducted through each department. The faculty member discusses with the chair of the department the overall percentages of teaching, research and service that s/he would like to be evaluated on. The department rates the faculty member for each area using a 0-4 rating system.

The rankings provide a linear comparison of every faculty member that determines the merit increase for that year.

External faculty reviews generally are not conducted within the College unless a faculty member requests them. When a faculty member requests an external review it is usually done by the Faculty Teaching Excellence Program or by faculty members outside the department or in other colleges on campus.

Teaching improvement resources for faculty within the College include department activities such as colloquia, portfolio development and classroom observations by other faculty. In addition, many of the faculty also participate in the University's Faculty Teaching Excellence Program (FTEP). Several college faculty have worked closely with FTEP in the development of programs for all professors on campus. Many departments within the College also participate in the Lead Graduate Teacher Program where the Lead Graduate Teacher serves as a liaison between the department faculty and the teaching assistants (TA's) in the department. The primary goal is improving the quality of teaching done by graduate students through seminars, one-on-one consultation, and improved communication.

The College of Engineering and Applied Science recognizes effective teaching in a number of ways. The departments designate an undergraduate teaching award. The College awards the Peebles Award for Innovation in Teaching and the Charles A. Hutchinson Teaching Award. During the past decade three faculty members in the College have been selected as system-wide Presidential Teaching Scholars. During the 1997-1998 academic year, Brian Argrow from Aerospace won the Boulder Faculty Assembly Excellence in Teaching Award. The Colorado Commission on Higher Education (CCHE) issued Program of Excellence Awards in four areas of the College.

d. Academic advising and support programs

Academic advising is one of the strengths of the College of Engineering and Applied Science. Improvements over the last decade have included: the addition of staff advisors in most of the departments, advising guides (information on academic policies, programs, major course sequences, probation and suspension, transfer credit and resources), a half-time humanities and social science advisor, and the development of the on-line Kontney Advising System for the College. Excellence in advising is recognized by the College’s Outstanding Advisor Award, which is awarded annually to a faculty member or staff member as determined by the undergraduate students in the College. Four staff have received the University’s Outstanding Undergraduate Advisor Award. Overall, students have indicated in the Senior Exit Survey that they are satisfied with their academic advising.

Academic support is available for all students in the College and for students who are taking engineering courses and planning to do an intra-university transfer. Students may obtain academic assistance through the following programs: Engineering 2001, the Engineering Quad, the Peer Advocate tutoring and academic support, SEED, Women in Engineering, and individual study strategy assistance through the Dean's office. Improvements over the last decade have included: tutoring and study strategy assistance for all students, increased support by the administration for academic support initiatives, hiring of a staff member in the Dean's office to develop academic support programs, and the development of the Peer Advocate Center.

3. Scholarship/Creative Work

The ***major research themes*** of the College are:

- Bioengineering,
- Environmental Engineering,
- Information Technology, and
- Materials Science.

These themes are reflected in the College's ***15 Interdisciplinary Research Centers***:

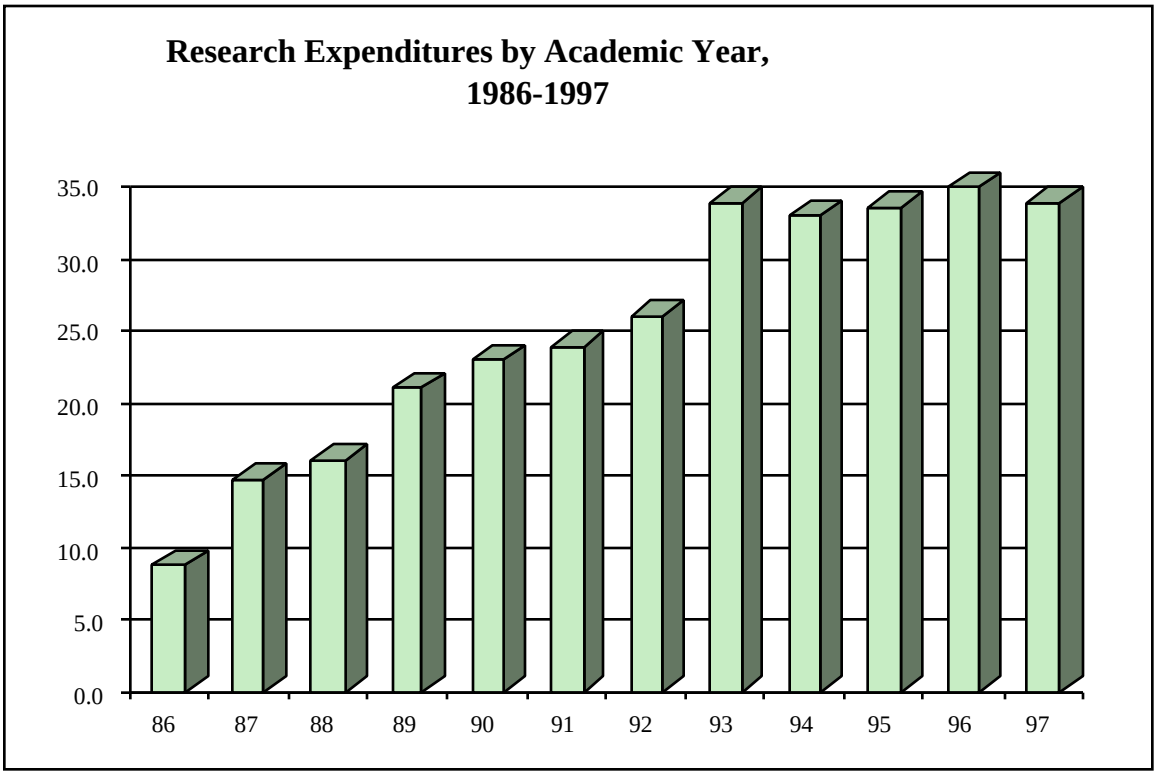
- BioServe Space Technologies
- Center for Advanced Decision Support for Water and Environmental Systems (CADSWES)
- Center for Advanced Manufacturing and Packaging of Microwave, Optical, and Digital Electronics (CAMP mode)
- Center of Applied Parallel Processing (CAPP)
- Colorado Center for Astrodynamics Research (CCAR)
- Center for Aerospace Structures (CAS)
- Center for Lifelong Learning and Design (L3D)
- Center for Pharmaceutical Biotechnology
- Center for Separations Using Thin Films (CSTF)
- Center for Space Construction (CSC)
- Center for Information Storage (CCIS)
- Joint Center for Combustion and Environmental Research (JCCR)
- Joint Center for Energy Management (JCEM)
- Micro Electronic Devices in Cardiovascular Applications (MEDICA),
- Optoelectronic Computing Systems Center (OCSC).

Faculty in the College are actively engaged in scholarship as evidenced by the scholarship productivity table (see below). Faculty recognition for the 1997-1998

year includes three NSF Presidential Faculty/Career awards (3 of 90 nationally in Engineering), 20 NSF Presidential/National Young Investigators (20 of 28 on campus), and three Faculty Awards for Women (3 of 50 nationally).

SCHOLARSHIP PRODUCTIVITY 1997 - 1998			
	Refereed journal Articles & Conference Papers	***Fellowship & Research Awards***	***Research expenditures***
Aerospace	128	6	$9,237,278
Chemical	77	8	$3,234,311
Civil, Architectural and Environmental	70	6	$4,079,673
Computer Science	80	2	$4,479,080
Electrical and Computer	56	16	$7,819,387
Mechanical	47	22	$2,761,754
Telecommunications	13	-	$244,865

Total research expenditures for the College during the 1998-1999 year were $30,000,000. Institutional support for research in the College is demonstrated by matching funds on grants, providing start-up funds for new faculty, and allowing a reduced teaching load for new faculty. Research expenditures have grown from 24 million in 1990 to 34 million in 1998.



The College believes that the integration of research and education is a vital part of the undergraduate and graduate experience. Research is integrated into the curriculum by: tenure track faculty teaching first-year courses, faculty sharing their research areas with students in introductory and upper division engineering courses, undergraduate and graduate students working with faculty on research projects, and faculty working with undergraduate and graduate students to conduct their own research. The College will continue to enhance the integration process through the Discovery Learning Initiative.

a. Discovery Learning Initiative

The College has been recognized as a major innovator in engineering pedagogy. Our initial efforts in the Integrated Teaching and Learning activities of both the College and the Integrated Teaching and Learning Laboratory have received wide praise and, as reported elsewhere, have dramatically improved retention and seem to have an important impact on recruiting.

The College recognized that the major valued added of a major research college is the connection of the undergraduates with the research activities of the faculty. Long before the Boyer Commission report was issued we were actively developing the Discovery Learning Initiative (DLI). DLI has as a goal significantly increasing the number of undergraduates who participate in research activities. We view this as the vertical integration of our curriculum, whereas the ITL is the horizontal integration of our departments. Web address: http://www.colorado.edu/engineering/co_dl.html

Adding more undergraduates to the research activities requires at least three changes. First, we must examine the curriculum to determine how to include research activities in a crowded course of study. Our approach to this, in addition to the common independent study courses and undergraduate research positions, is to develop the option of a capstone research experience to parallel the capstone design experience which is currently part of our curricular goals. This change will allow the students to pursue activities that interest them without incurring extra time in their program. In addition, the new five year co-terminal BS/MS program will encourage students to take research in their undergraduate activities to help shorten their overall BS/MS program.

In addition to flexibility in curriculum there must be space in labs to support additional students in research activities. Currently research labs in the College are overcrowded. Therefore we proposed a Discovery Learning Center - 45,000 ft^2 to house research efforts which propose to expand to include undergraduates. This is a very important project as the amount of project space for students is in very short supply in the college. The Discovery Learning Center has now been approved, is in the design phase, with groundbreaking scheduled for May 2000.

The final component to a successful undergraduate research experience is projects to which the undergraduates can make substantial contributions and feel the satisfaction which comes from discovery. To this end we are working with industry to develop a series of research projects related to faculty interest and expertise but with a shorter term industry focus. Industrial partners together with graduate students and faculty will mentor the undergraduates. Of course, normal research projects will also be open to undergraduates.

4. Service

Service as recognized by the College of Engineering and Applied Science includes advising undergraduates, participating on campus committees, and serving on state boards and professional society boards. Engineering faculty

involved in leadership positions on campus committees are: John Daily, former Chair, Boulder Faculty Assembly; Robert Schnabel, Associate Vice Chancellor for Academic and Campus Technology, and Chair, Alliance for Technology Learning and Systems (ATLAS); and Garrett Model, Diversity Committee. Several faculty from various departments serve on committees of professional societies. Dean Ross Corotis is a member of the Executive Board of the Engineering Dean's Council, and Associate Dean, Michael Lightner, is on the IEEE Board of Directors. At the state level, John Daily serves on the Colorado Hazardous Waste Commission. Also, at the national level, Delores Etter (on leave from Electrical and Computer) is currently the Deputy Undersecretary of Defense for Science and Technology.

C. S.W.O.T. Analysis

Strengths

- Quality of the faculty overall and of new faculty
- Level and quality of research
- Academic strength of undergraduate and graduate students
- Quality of teaching/instruction
- Commitment to and success with curricular and pedagogical innovations

Weaknesses

- Space limitations within departments and the engineering center
- Faculty overload in several departments and concerns with the faculty salary levels.
- Resources - less than 10% of the College expenditures come from state funding
- Continued contact with alumni

Opportunities

- New resource opportunities
- New student programs
- Opportunity for new faculty hires

- Opportunity for expanding industrial relations
- Opportunity for working with other UC-Boulder academic colleges/programs

Threats

- Faculty losses
- Lack of resources for new programs
- Increased competition for quality undergraduate students, and the national declining enrollments and retention of graduate students

III. Action Plan

The College of Engineering and Applied Science Action Plan is embodied in our goals for the next five years and was developed as part of the 1999 budget process. The following items present the rationale for the plan, goals, budget and implications in a wide variety of College activities. Our action plan is, through fund raising, faculty development, and strategic partnership, to realize these goals.

College of Engineering
Strategic Academic Goals

1999-2004

Nature of Engineering

- Modern engineers will have multiple careers and many different jobs
- Their disciplinary expertise upon graduation will be obsolete within five years
- They must maintain a constant learning activity throughout their career
- They will work in heterogeneous teams involving multiple engineering disciplines along with other disciplines
- They will work in global companies with a diverse mix of cultures

Overarching College Themes

The College response to the nature of engineering has been encapsulated in four themes for the Capital Campaign

I Educating for Leadership

II Engineering a Better Future

III Integrating Research and Learning

IV Extending the College to the Community

College of Engineering Academic Vision

- Provide our undergraduate with an outstanding, modern education which:

  –prepares the foundation for a diverse lifelong career

  –provides the basis for a beginning career in a highly competitive environment

  –supports a diverse community with diverse learning styles

  –continues to provide national leadership in engineering education innovation with a focus on the student as learner and a learner-centered curriculum

- Provide our graduate students with a world class environment in which they:

  –prepare for a career in research and development

  –can extend the state-of-the-art in their field of interest

  –can enrich their education through multidisciplinary research and educational opportunities

- Provide our faculty and staff with:

  –a modern environment to carry our their education and research activities

  –the necessary infrastructure support to excel at both education and research

  –an environment which supports innovation and multidisciplinary activities

  –a heterogeneous environment open and facile enough to partner effectively with industry and reflect the dynamic nature of engineering

- Provide our distance students with:

  –an effective modern environment to pursue their professional educational goals

  –access to the research opportunities of the college

  –a broad range of course, certificate, and degree possibilities

  –courses which reflect both academic rigor and industry practice

- Expand our outreach to the community:

  – to build an understanding of engineering as a career choice among K-12 students, teachers, and counselors

– to support under-represented groups in their pursuit of a technological and scientific career

– to build knowledge of, and respect for, CU Boulder as a broadly supportive environment for all groups to pursue a higher education

Overview

- These academic visions of the College of Engineering are complex with many overlapping requirements

- We will present a number of programmatic foci and the goals associated with those foci

- The College of Engineering Academic Focus areas are:

  – Student Programs (SP)

  – Discovery Learning (DL)

  – Integrated Teaching and Learning (ITL)

  – Technology-enhanced Learning (TEL)

  – Design Experience (DE)

  – Outreach (O)

  – Communication Skills (CS)

  – Engineering Fundamentals (EF)

  – Modern Curriculum (MC)

Student Programs

- Academic and Career Advising

- Tutoring/Mentoring

- SEED, WIEP

- Institutional advising
    - –petitions, policy and procedures
- Student organizations
- Career and Financial Counseling
- Computing support
    - –engineering typically requires higher powered computers than H&SS
    - –requires more frequent replacement
    - –new ICWG policy is reducing $ to engineering

Student Programs - Goals

- Basic assessment metric is number of students served
- Goal is 100% of students served
- More important goal is that students get the help they need when they need it
    - –Retention
    - –Average GPA
    - –Satisfaction upon graduation, job placement

Discovery Learning

- Discovery learning is the enrichment of the undergraduate curriculum through connection with our outstanding research and graduate program
- Discovery learning has a component focused on the undergraduate program and a component focused on the graduate program
- The first prerequisite for discovery learning is outstanding graduate students and faculty

- As a major research university we have an important resource for the undergraduate program

- Our discovery learning initiative is aimed at involving as many undergraduates as possible in the research activities of the college

Discovery Learning - Goals

- Increase the % of undergraduate students having a research or independent study experience during their undergraduate career

- Provide environments which support undergraduate research

- Develop curricular flexibility to allow undergraduates time for research experiences

- Increase the number of students in the BS/MS program

- Reverse the decline in graduate enrollment

- Increase the number of students in both the on-campus and distance Masters program

Integrated Teaching and Learning

- ITL has caused a major change in undergraduate education by stressing active, hands-on, collaborative laboratory and design based learning

- Increasing these characteristics throughout the curriculum is the next step in modernizing the college curriculum

Integrated Teaching and Learning - Goals

- Develop a continuing sustainable funding model for ITLL

  – support staff

  – support equipment replacement

–support new, state-of-the-art curriculum experiments

- Generate funds to ITLize the college curriculum

Technology-Enhanced Learning

- The college is a leader in technology-enhanced learning
  - –Lab courses
  - –computer usage
  - –simulation
- A major goal is to continue this exploration and refinement of engineering pedagogy

Technology-Enhanced Learning - Goals

- Develop new uses of technology to support the learning of our students
- Deploy these techniques throughout the curriculum
- Import pedagogy from other universities and support its deployment
- Maintain and increase our reputation as a leader in engineering education reform

Design Experience

- The key to understanding design is to have significant design experiences in a safe environment
- Intelligent trial and error - iteration - is key to developing a design expertise - students need repeated exposure to understand what design means
- Our goal is to develop significant design experiences in each year of the curriculum with special emphasis on the freshman and senior year

Design Experience - Goal

- 100% of our students will have at least two significant design experiences during their undergraduate career

  –To reach this goal will require updated design studios, appropriate equipment, and staff and faculty support

Outreach

- The college has significant outreach to K-12 students and teachers

- The aim is to make engineering as a career choice interesting to students early in their studies

- This also implies that the students, teachers and administrators understand the importance of science and math to support an engineering career as well as being ends in themselves

- We also have special focus on underrepresented populations in engineering

Outreach - Goals

- Provide comprehensive outreach to Colorado schools

  –First focus on key population centers including the Front Range and Western slope

  –On a rotating basis develop connections with less populated portions of the state

  –Collaborate with other institutions since our first goal is a knowledge of engineering as a career

- Increase the number of women and ethnic minorities choosing engineering and those attending CU Boulder

Communications Skills

- Our students must have significant practice in engineering related written and oral communication

- This experience cannot be relegated to a single UWRP course

  – We require significant writing and speaking in our curriculum and thus require the ability to provide professional critiquing and student support

Communication Skills - Goals

- Our goal is to increase the curricular emphasis on written and oral communication experiences for our students

- Students should be provided with critique of their work, workshops and coaching during their engineering courses

Engineering Fundamentals

- In order to have a long technical career our students must have a strong knowledge of engineering fundamentals

  – while still understanding the state-of-the-art

- They must also become lifelong learners

  – understanding their learning styles

  – developing facility in learning and problem solving

Engineering Fundamentals - Goals

- Have all students who take the Fundamentals of Engineering exam, for certification as a registered Professional Engineer, pass the first time

- To achieve satisfaction on knowledge of the fundamentals of engineering from our alumni surveys

  − Maintain small class sizes in the critical years for fundamentals - the sophomore and junior years

Modern Curriculum

- Engineering is a profession which begins at the BS level

- Our students should be prepared to enter the modern engineering workplace, where employers expect new hires to be productive with very little additional training

  –Requires that our curriculum reflect modern engineering practice and our labs be on par with industry

Modern Curriculum - Goals

- Increase the number of our students obtaining jobs in the field of the their choice

- In addition, our employer surveys should indicate satisfaction with our new graduates