Recruiting Students in Engineering: Assessment Strategies and Retention

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NSF ReACH Project Goals

To recruit students with academic talent and financial need into the College of Engineering and Applied Science at UCD and to provide the financial, academic and social supports that will motivate and equip these students to complete their degrees in a timely manner and join the STEM workforce.

Overall Goals for ReACH Program

- Increase degree persistence and completion among engineering majors,
  - 80% of ReACH Scholars will stay continuously enrolled in UCD from the time of their award to graduation or the end of the grant term.
  - 70% of ReACH Scholars will earn or be on track to earn a baccalaureate degree in engineering within five years of initial enrollment in the engineering program.
- Increase the number of engineering majors pursuing careers in the field,
  - 80% of the ReACH Scholars cohort will plan to pursue a career in the field.

Overall Goals for ReACH Program

- Increase the Number and Diversity of Engineering Majors at UCD:
  - The number of students enrolled in engineering at UCD will increase.
  - The number of financially disadvantaged students enrolled in engineering at UCD will increase.
  - The number of minority and first-generation students enrolled in engineering at UCD will increase.

Significance of Project and Rationale

Need to Prepare More Engineers:

- The importance of higher education in science and engineering (S&E) is increasingly recognized for:
  - their impact on innovation and economic development.
  - providing advanced skills needed for a competitive workforce
  - providing the research necessary for innovation (graduate education)

- BS in (S&E) degrees have constituted ~1/3 of all baccalaureate degrees awarded over the last 20 years, with only narrow fluctuation except for an increase in degrees in psychology and a decrease in the percentage in engineering (from 7% to 5%) (*NSF, 2006*).

Significance of Project and Rationale

Need for Financial Assistance in Colorado:

- Share of the general funds devoted to higher education has decreased by 56% since FY 1982 (from 23% in FY 1982 to 10.1% in FY 2005).
- In FY 2005, Colorado invested $128.55 of tax funds per capita for higher education, ranking 48th in the nation. At the same time that state funding for higher education has absorbed severe cuts, student enrollment has grown at increased rates (by 22.7% from FY 2001 to FY 2005).
- This combination of enrollment increases and funding cuts has caused a dramatic decrease in state funding per resident student. From FY 2002 to FY 2005, students of the University of Colorado system experienced a 40% drop in state funding.
- The decline is even more dramatic when adjusted for inflation (Protopsaltis, 2005) and current economic conditions.

Significance of Project and Rationale

Downtown Denver Location:

- UCD typically attracts urban students from diverse backgrounds, many with financial need.
- For the College of Engineering and Applied Science, the year-to-year retention rate for first-time degree seeking freshmen was 56% in 2003 and 76% in 2004.
- The six-year graduation rate for first-time full-time degree seeking freshmen who entered the college in 1999 was 38%.

Significance of Student Support Services and Programs

- Academically focused retention programs are based on the assumption that the higher a student's academic competence, the better the performance and the greater the likelihood of staying in school (*Adelman, 1999; Bean, 1983, 1985; Ishitanti & DesJardins, 2002*).

- College retention and performance are influenced by non-academic factors: academic self-confidence motivation for achievement, institutional commitment and social support. (Covington, 2000; Dweck, 1999; Eccles & Wigfield, 2002).

Significance of Student Support Services and Programs

- Intent is to create a social and learning community that fosters common program goals to promote academic achievement and persistence to graduation.

- Faculty-student mentoring, academic counseling, and peer tutoring help improve levels of student involvement, motivation and academic self-confidence and in turn increase levels of institutional commitment and engagement (*Mangold et al, 2003, Padgett & Reil, 2003*).

Significance of Annual orientation/enrichment event

- An engaging and comprehensive program orientation will cultivate students' identification and connections to the academic and social culture of the College (*Fidler, 1991; Tinto, 1993*).

Significance of Supplemental Instruction for Freshman

- Studies indicate that across institutional types, disciplines, precollege student preparation levels, and ethnic groups, SI participants consistently outperform their peers who attempt the same courses on their own (*Congos & Schoeps, 2003; Hensen & Shelley, 2003; Ogden, Thompson & Russell, 2003; Ramirez, 1997*).

- The SI structure also provides students with a framework for studying together, recognizing that peer support can be an important long-term strategy for academic achievement.

ReACH has Three Main Components

1. A pre-collegiate summer workshop designed to recruit students into the College of Engineering and Applied Science at UCD(College) and the ReACH Scholars program;
2. Scholarships that will provide up to $7,600/year for full-time students enrolled in the College who demonstrate financial need, academic achievement, and the commitment to pursue a STEM career;
3. A network of academic and social support that will help ReACH Scholars persist in their studies at a high level of achievement, complete their BS degree in a timely manner, and pursue career and educational opportunities in the field.

Steering Committee Organization

- Members from various University organizations were invited to join the ReACH Steering Committee during the planning year.
- They each represent a crucial component of the institution to provide support for
  - outreach and recruitment,
  - student advising,
  - student services,
  - financial aid support,
  - curriculum development and mentoring

Steering Committee Organization

- Faculty from College of Engineering:
  - one faculty mentor from each of the four engineering majors at the College of Engineering at UCD: Computer Science and Engineering (CSE), Civil Engineering (CE), Electrical Engineering (EE) and Mechanical Engineering (ME).
- Pre-collegiate Program:
  - Director to help with student recruitment from High Schools for the summer program
- Student Services Representative:
  - Help in providing program support

Steering Committee Organization

- University's Financial Aid Office Representative:
  - Help coordinate assistance to eligible applicants in FASFA form completion and provide eligibility information
- University's Experiential Learning; Internship and Career Center Representative:
  - Help with career Planning, internship, Coop, employment
- College of Engineering Student Services:
  - Provide specialized student advising, orientation, and services for engineering students

Steering Committee Organization

- Colorado MESA: Mathematics, Engineering, Science Achievement:
  - Outreach support and help with minority engineering student recruitment
- Program Assistant:
  - To provide staff support for the ReACH program

Pre-Collegiate Summer Program

- The Pre-Collegiate program at UCD provides funding and support for first generation college-bound high school students to take specially designed university level courses during the summer of their junior and senior years.
- These students have higher degree of success and many will attend the University of Colorado Denver upon graduation from high school.

Make up of Students in Our Pre-Collegiate "Topics In Engineering" Summer Course

- Criteria:
  - First generation-college bound students and a G.P.A of 2.5.
- Student Selection:
  - The Pre-collegiate personnel
    - present program to students nominated by teachers and counselors who meet the program criteria.
    - hand out applications to those who show interest.
    - Interview those who turn in completed applications.
    - Selected students are admitted into the program.

Make up of Students in Our Pre-Collegiate "Topics In Engineering" Summer Course

- Recruitment Cycle:
  - September, October, and November

- Schools:
  - Alameda, Denver School of Science and Technology, Gateway, George Washington, Hinkley, John F. Kennedy, North, and Standley Lake.

Make up of Students in Our Pre-Collegiate "Topics In Engineering" Summer Course

Year/ Ethnicity	Asian	Black	Hispanic	Native American	White	Other	Did not identify
2007	1	3	8	1	2	3	
2008	0	1	3	1	3	2	2
2009	8	1	7				

Year	Female	Male
2007	8	10
2008	5	6
2009	6	10

Related Family Role Models

Did participants have an engineer in their mediate family?

Year	Engineers in Family	
	Yes	No
2007	1	12
2008	0	11
2009	1	16

Summer "Topics in Engineering" Course

- A new multidisciplinary pre-collegiate summer course was designed during the first year of the award.
- First taught during summer 2007.
- Students taking this five-week course completed two parallel engineering projects:
  1. Game Software Automata (Tuesdays 8:00 to 11:50)
  2. Earthquakes & Engineering (Thursdays 8:00 to 11:50)
- A team of three instructors team-taught the course

Game Software Automata (GSA) Objectives

- The course strategy is to lead students to conceptualize and analyze an interactive puzzle-solving simulation system.
- The premise is that this process will lead students to a greater intuitive understanding of a moderately complex system as well as an understanding of the methods of computer simulation.
- Weekly class periods introduce the necessary engineering concepts, any corresponding model, relevant algorithms, programming strategies, and methods for analyzing results.

Game Software Automata (GSA) Objectives

- The puzzle programmed is Dan Gilbert's *Triazzle*© at http://www.triazzle.com/, chosen especially for its combinatorial properties, within Microsoft's XNA game programming framework at http://msdn.microsoft.com/en-us/xna/default.aspx
- The puzzle is designed to operate in four different interactive modes, from fully automatic to fully interactive.
- This program flexibility shaped the design of the course by exposing multiple engineering tradeoffs involved in the building of a software solution.

Earthquakes & Engineering Objectives

- Understanding the problem and difficulty of Prediction: Engineering seismicity
- Avoidance: Effects of ground shaking and failure, like motion amplification and soil liquefaction, on structures and avoidance mechanism
- Prevention: Analysis of the performance of structures under strong seismic events and affordable destruction prevention measures.
- Projection: Projections of potential loss of lives and injuries, structure destruction, ground failures, and associated social, economic, and political impacts
- Planning: Development of action plans to minimize all the ill impact of a strong seismic event.
- Finalizing a final learning report.

Impact of "Topics in Engineering" Course

Sample Questionnaire Results

Number of students considering	2007 Total=13	2008 Total=11	2009 Total=17
a degree in engineering after taking this course	5	7	10
a degree in engineering if they had scholarships	5	5	5
this course helped them to make a decision about pursuing a degree in engineering	6	6	11

Outreach/Recruitment Efforts

University of Colorado Denver
Downtown Campus

College of Engineering and Applied Science

Become a REACH Scholar!

The REACH, or Recruiting Engineers to ACHieve, Program in the UC Denver College of Engineering and Applied Science seeks talented students to engage in engineering disciplines and the REACH Scholars Program.

Learn more about the REACH Program online: http://www.cudenver.edu/REACH

University of Colorado Denver
Downtown Campus

REACH:

Recruiting **E**ngineers to **ACH**ieve

The College of Engineering and Applied Science offers prestigious National Science Foundation Scholarships to new and financially eligible UCD students enrolled full-time in one of the four engineering majors:

- Civil Engineering
- Computer Science and Engineering
- Electrical Engineering
- Mechanical Engineering

Please direct inquiries to:

Ms. Frances Moore
E-mail: Frances.Moore@cudenver.edu
Telephone: 303-556-4083

National Science Foundation
WHERE DISCOVERIES BEGIN

NSF Scholarships

Through the NSF REACH Scholars Program, scholarship recipients receive up to $7,600 their first year (depending on need) and up to $3,800 the second year to study at the UCD College of Engineering and Applied Science.

University of Colorado Denver
Downtown Campus

College of Engineering and Applied Science

Outreach/Recruitment Efforts

National Science Foundation Scholarships

National Science Foundation
WHERE DISCOVERIES BEGIN

Eligibility Criteria

♦ Open to students with the status of United States citizen, refugee alien, or permanent resident alien at time of application.

♦ Open to incoming freshman (high school seniors) who have been accepted into the UCD College of Engineering and Applied Science (full-time at UCD),
or
current full-time undergraduates enrolled in the UCD College of Engineering and Applied Science,
or
current full-time students who are eligible for transfer to the UCD College of Engineering and Applied Science.

♦ Financial need must be demonstrable under applicable U.S. Department of Education guidelines used on the Free Application for Federal Student Aid (FAFSA) form.

♦ Cumulative GPA of 3.0 or above.

What does the REACH Program offer?

The REACH Program at UC Denver has three main components:

1. A pre-collegiate summer program designed for high school juniors and seniors interested in the engineering disciplines. Refer to the following website for a specific summer program: www.cudenver.edu/REACH/REACHsummerPrograms.html .

2. Scholarships that will provide up to $7,600 the first year for full-time students enrolled in the College of Engineering who demonstrate financial need, academic achievement, and a commitment to pursue a career in Science, Technology, Engineering, or Mathematics (STEM).

3. A network of academic and social support that will help REACH Scholars to achieve a high level of academic success, complete their baccalaureate in a timely manner, and pursue career and educational opportunities in the field.

How to Apply:

Detailed information is available online: www.cudenver.edu/REACH

Apply to UCDHSC:

www.cudenver.edu/Admissions

Apply for Financial Aid:

www.cudenver.edu/finaid

Apply for a REACH Scholarship:

online: www.cudenver.edu/REACH

or submit by hard copy (attached).

Send application materials to the REACH Program:

Professor G. Alaghband,
REACH Application
Department of Computer Science and Engineering
Campus Box 109, P.O. Box 173364
University of Colorado Denver
Denver, Colorado 80217-3364

Outreach/Recruitment Efforts

- A dedicated website for the NSF ReACH scholarship program has been designed:

  http://www.cudenver.edu/REACH

- The site provides links to the ReACH program, application, summer programs, UCD resources, student resources and ReACH contact information.
- The website provides many campus and external resources and current events to students.
- ReACH Scholars are featured on this website.

Outreach/Recruitment Efforts

- The Brochure, Application form, letter of invitation/information were distributed to help inform and recruit potential students:
  - Email to 509 Colorado high schools' counselors,
  - UCD Academic Student Advising Center (ASAC),
  - UCD Scholarships Office,
  - UCD Admissions Office,
  - UCD Pre-Collegiate Office,
  - Colorado MESA,
  - High school students interested in engineering disciplines at two UCD-held Open Houses
  - All New UCD Orientations (held during Winter break and once a week during June, July, August)
  - All incoming and Freshman engineering students

Selection Criteria

- GPA (min. 3.0, SAT and ACT scores),
- Eligibility for Financial Aid
- Essay:
  1. Briefly describe your commitment to education and in which ways engineering fit into your future goals.
  2. Explain reasons for your interest in your intended major and describe where you hope your career will lead you ten years from now.
  3. What would you like the REACH (Recruiting Engineers to ACHieve) Scholarship committee to know about you that will distinguish you from other applicants?

Academic Advising and Orientation

- An orientation meeting is held early every semester to introduce the scholars to the program, faculty mentors, peer mentors, and each other.
- ReACH Scholars were assigned a faculty mentor from each of the four departments in the College of Engineering. Faculty mentors provide academic advising, mentoring, and support to the ReACH Scholars.
- Students have been asked to meet with their faculty mentor several times a year.

Activity Requirements

- Biography & Photo:
  - Scholars submit their own bio and photo for ReACH website
- Student Mentors:
  - Several scholars are selected as peer mentors,
  - They provide SI, tutoring, networking, and leadership role
  - Maintain regular office hours,
- Email Server:
  - Facilitates communication & networking
- Student-Faculty Mentor:
  - Regular meetings, academic advising, research, faculty reports to the PI

General Activity Requirements

- Attend **at least three** of all formally scheduled REACH scholarship events, such as the:
  - Welcome Engineering Reception
  - UCD Research Symposium
  - Freshman Convocation
  - Career Center Job Fair
  - Student Success Event

General Activity Requirements

- Attend at least one (of interest) **engineering** student organization event on campus per semester.
- Prepare a semester and annual Engineering Portfolio, outlining experiences at UCD, engineering research, projects, etc.
- Provide suggestions pertaining to the areas in Engineering College and student services needing improvement.
- Maintain a checklist of all activities including meetings with faculty mentors required by the REACH scholarship for review on a semester basis.
- Research or participate in an Engineering Research Project by the faculty mentor.

Career Related Event Activities

- Visitation to different government agencies and industries to raise the awareness of various career opportunities available to them.
- Visit agencies and industries for potential summer internships or a part-time job with good learning experiences.
- Internship, visit http://thunder1.cudenver.edu/exl/index.html for possible internship opportunities.
- Attend classes held by the NSF REACH Research Assistant.

Internship and Career Services for Engineering Students

- Presentations by the Experiential Learning Center (ELC) providing information on:
  - services and resources ELC offers,
  - volunteering,
  - service and service learning,
  - UCAN Serve,
  - Undergraduate Research Opportunities Program (UROP),
  - Research and Creative Activities Symposium,
  - internships,
  - cooperative education (Co-ops),
  - academic credit for internships,
  - resumes, cover letters, application materials, and interviewing assistance.

Professional Organizations

- American Indian Science and Engineering Society (AISES)
- American Society of Civil Engineers (ASCE)
- American Society of Mechanical Engineers (ASME)
- Association for Computing Machinery (ACM)
- Institute of Electrical and Electronic Engineers (IEEE)
- National Society of Black Engineers (NSBE)
- Society of Automotive Engineers (SAE)
- Society of Hispanic Professional Engineers (SHPE)
- Society of Women Engineers (SWE)
- Women & Minorities in Engineering Program (WMEP)

Honorary engineering societies

- Chi Epsilon (civil engineering),
- Eta Kappa Nu, (electrical engineering),
- Pi Tau Sigma (mechanical engineering)
- and Pau Beta Pi (all engineering) also have student chapters in the College of Engineering and Applied Science.
- Membership in these societies is by invitation only.

Web development course

- **Scheduled over two semesters**
- Oct 2rd 2009: Design a simple portfolio website with single page.
- Oct 23th 2009: Design a portfolio website with multi pages
- Nov 6th 2009: Design a portfolio website with multi pages (cont.)
- Nov 13th 2010: Improve website appearance with CSS (Cascading Style Sheets)
- Mar 5th 2010: Create a portfolio website with Google Sites
- Mar 12th 2010: Web hosting and maintenance.

http://ouray.cudenver.edu/~ltpvu/WebDesign/
(Developed and taught by, Lan Vu, PhD Student)

ReACH Scholars- AY '07-'08

Major/ '07-'08	Total	Freshman	Sophomore	Junior	Senior	Xfer	Status
Mechanical	3	3					1 dropped
Electrical	2	2					1 dropped
Civil	1	1					1 changed major
Computer Science & Eng.	0						
Summary	**6**	**Returning: 4**					

One changed major to Architecture & Planning; but two years later changed to Mechanical Engineering.

Lesson Learned during the first year

- Had a late start, few students (all six starting as freshman) meeting the program eligibility were recruited.

- Two students did not participate in the mentoring sessions, did not respond to calls for meetings, and did not meet with their faculty mentors, did not perform well and were placed on academic probation.

➢ All scholars were asked to read and sign the activity requirements at the orientation meeting in order to accept their award after the first year!

ReACH Scholars- AY '08-'09

Major/ '08-'09	Total	Freshman	Sophomore	Junior	Senior	Xfer	Status
Mechanical	8	3	2	3		2	1 Changed major
Electrical	6		4	2		3	
Civil	4	4					
Computer Science & Eng.	1	1					
Summary	**19**	**Returning: 18**					

Two returning scholars became "Peer Mentors".
Two new students were struggling and needed to improve their performance.
One changed major to History.

ReACH Scholars- AY '09-'10

Major/ '09-'10	Total	Freshman	Sophomore	Junior	Senior	Xfer	Status
Mechanical	7		3	3	1		
Electrical	9		1	6	2	1	2 graduated in Dec. '09, 1 joined industry, 1 cont. w. grad school
Civil	3		1	2			1 changed major
Computer Science & Eng.	2		1	1			1 dropped
Summary	21	**Returning: 18**					

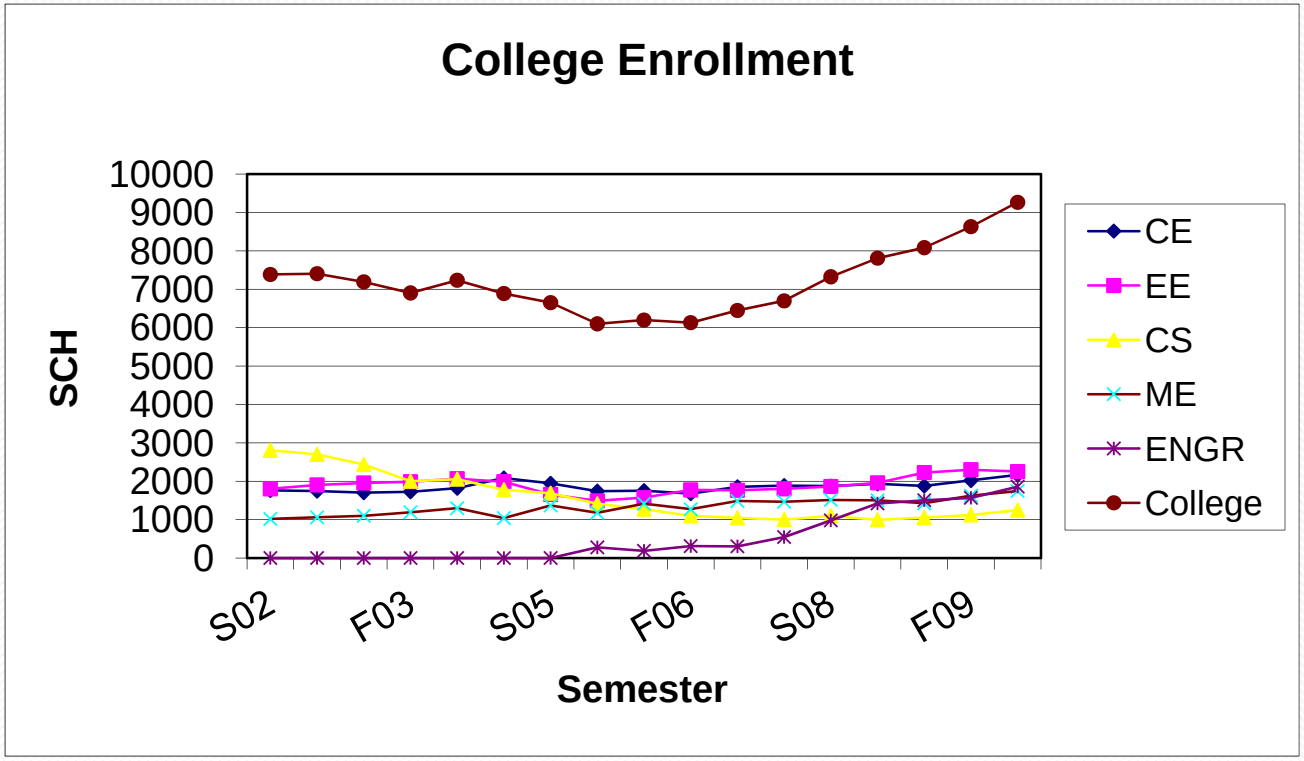
One changed major to Phsychology
One dropped from ReACH program and undecided regarding new major
Five returning students became peer mentors

Makeup of ReACH Scholars '07-'10

Ethnicity	Number of students
Asian	5
Black	2
Hispanic	4
Caucasian	11
Unknown	3

Gender	Number of Students
Female	3
Male	22

Enrollment History



Observations

- Students appear to have a different perception of what Civil Engineering discipline is about.
- The extensive Math and Science requirements for engineering and Civil Engineering Specifically seem to surprise and disappoint them.
- Summer courses to introduce high school students to engineering projects should be encouraged and become available to a wider group of students
- Students do not in general seek academic advising unless they are required to.
- Students seldom take advantage of Peer Mentoring.

Challenges & Lessons Learned

- Summer course and institutional support:
  - A summer course such as the "Topics in Engineering" is a great way to introduce the engineering disciplines to high school students.
  - Design innovative projects at appropriate levels in each discipline or in multidisciplinary areas. High school curriculum does not cover engineering disciplines.
  - ➢ However, these projects require institutional resources, funding, and should be available to a larger group of students

Challenges & Lessons Learned

- Coordination and collaboration among the university entities:
  - The steering Committee and its make-up seem like a natural way to organize the academic units.
  - For the most part there is little if any communication between these entities.
  - College of Engineering at UCD needs to adjust to its changing student demographic. Several years ago average age of undergraduate students was 27, now we have many 18 year olds. Some majors (CE for example) rarely have entering freshman students.
- Website & Institutional Support