To: CEP
From: School of Engineering
Re: Feedback on General Education reform

Our responses are interleaved with the questions that were posed in your request for feedback.

For **all** divisions' Councils of Chairs

A. Interdisciplinary Topical Clusters

After reviewing Section 7 of the pre-proposal (pp. 19-23), can you suggest any candidate Interdisciplinary Topical Clusters that some department(s) within your division would be interested in participating in?

There a many excellent Topical Clusters that could be suggested that include at least one course from the Engineering SA Breadth courses. Although there has been no consultation with the other divisions, here are a few examples.

Digital Media and the modern "theater"
FDM20C: Intro to Digital Media
CMPS80K: Foundations of Interactive Game Design
TA10: Introduction to Theater Design and Technology

Evolution, the Human Genome, and Bioethics
BIO80E: Evolution
BME80H: The Human Genome
BME80G: Bioethics in the 21st Century: Science, Business, and Society

Technology and the Environment
ES80B: The Ecological Forecast for Global Warming
EE80J: Renewable Energy Sources
TBS

B. Ways of Learning

1. Assuming we should have at most five such requirements, do you have suggestions for paring this set down (by eliminating or combining requirements)?

Although it was not discussed by the group, one chair suggested that possibly "Cross-cultural understanding" and "Race, ethnicity, gender, sexuality" could be combined. He wrote: "Combining the two E items would pair the list down. Several of the items are indeed "ways of learning", such as formal reasoning, critical thinking, statistical reasoning, and creative thinking. Others are areas of modern importance, focused on contemporary issues. One of the historic issues with E was whether or not learning about old cultures versus current "E" issues was appropriate, and it was deemed to be so. However, in looking toward GE for the future, it might be worth considering if items such as cross-cultural, the environment, or technology &

society must be focused on the present and the future. This does not eliminate history, for example, but instead indicates that courses carrying these designations must emphasize how past lessons and experiences apply to the future."

2. Keeping in mind that this set already reflects input gained from CEP's discussions with individual departments (for example we found little support for an "ethical reasoning" requirement, though this comes up at other universities), do you think there is an obvious candidate requirement that should be added?

Five of the Baskin School of Engineering majors (accounting for 75% of declared majors and 90% of new frosh) include requirements in ethical reasoning. However, this is a major-driven requirement and, perhaps as with disciplinary communication, majors should explicitly consider what types of ethical reasoning may or may not be appropriate for their students.

3. How would you amend the suggested educational objectives? Please answer with specific re-wordings of the text.

No suggestions at this time.

<u>For **Engineering** Council of Chairs</u>

1. Please propose a description of a SA breadth requirement in the area of Engineering. Descriptions can be short, of the sort seen for Ways of Learning above.

Engineering courses that satisfy the general education requirement should address at least one of the following:
How is some modern technological artifact created (e.g. software artifacts - programs, hardware artifacts - computer circuits and systems)?
What tools are used in the creation of such artifacts and how do those tools work?
3) How does some human created technological artifact impact society? If the impacts are negative, how are they being addressed? If the impacts are positive how is that changing society?

2. Also provide explicit educational objectives for the requirement.

The general education objectives for courses in engineering and technology are to enable students to understand the impact of technology on their personal lives, on their chosen area of study, and on society as a whole. In addition, these courses can provide students with the knowledge they need in order to apply engineering tools and technologies in their lives and careers. This can range from computers in the arts to biomedical devices implanted in human bodies.

3. Describe at least three courses that in your view would make good candidates for having the (Natural Sciences and) Engineering designation. If they are existing courses, provide their catalogue course descriptions. Just as important, please give examples of courses in the area of Arts (and Humanities) that are **not** suitable and say why they are not suitable.

There are numerous courses that fit the proposed model of general education courses. We list some of them below grouped according to the three categories outlined in the CEP request for feedback: overview, introductory, and topical.

Overview

BME5: Introduction to Biotechnology
Introduces the tools and applications of biotechnology in the fields of medicine, agriculture, the environment, and industry.

CMPS10: Introduction to Computer Science
An overview of the theory, foundations, and practice of computer science with emphasis on what computers can and cannot do, now and in the future. Topics include algorithms and data, correctness and efficiency of algorithms, hardware, programming languages, limitations of computation, applications, and social issues. No programming skills are required as a prerequisite. Major concepts and open problems in computer science are presented without reliance on sophisticated mathematical tools.

Introductory:

CMPE8: Robot Automation: Intelligence through Feedback Control
Introduction to dynamical systems, feedback control, and robotics. Fundamental concepts in dynamical systems, modeling, stability analysis, robustness to uncertainty, feedback as it occurs naturally, and the design of feedback-control laws to engineer desirable static and dynamic response. Course includes an introduction to MATLAB and programming in MATLAB. Enrollment restricted to first-year students and sophomores.

CMPE80N: Introduction to Networking and the Internet
Introduction to the evolution, technological basis, and services of the Internet, with descriptions of its underlying communications structure, routing algorithms, peer-to-peer hierarchy, reliability, and packet switching. Network security, mail, multimedia and data compression issues, HTML, and digital images.

CMPE80U: Ubiquitous and Mobile Computing
Ubiquitous computing integrates computer and communication technology with day-to-day life. Ubiquitous and mobile technology includes: MP-3 players, camera cell phones, Bluetooth headsets, sensor networks, and new emerging technologies. Course provides an overview of the technology and economics of ubiquitous computing.

CMPS5C: Introduction to Programming in C/C++
Introductory programming for students who have no prior programming experience. Students learn programming and documentation skills as well as algorithmic problem-solving and programming methodologies. Introduces computers, compilers, and editors. Students write medium-sized programs.

CMPS80K: Foundations of Interactive Game Design
Surveys history, technology, narrative, ethics, and design of interactive computer games. Work in teams to develop novel game-design storyboards. Intended as a generally accessible undergraduate course in which students can explore the interplay of narrative, graphics, rule systems, and artificial intelligence in the creation of interactive games. Programming experience not required.

ISM50: Business Information Systems
Addresses the use of information systems (IS) within a business enterprise. Subjects include computer hardware and software concepts, system design and implementation, telecommunications, data management, transaction-based systems, management information systems, and the use of IS to compete. Intended for information system management and business management economics majors.

Topical

BME80G: Bioethics in the 21st Century: Science, Business, and Society
Serves science and non-science majors interested in bioethics. Guest speakers and instructors lead discussions of major ethical questions having arisen from research in genetics, medicine, and industries supported by this knowledge.

BME80H: The Human Genome
Course will focus on understanding human genes. Accessible to non-science majors. Will cover principles of human inheritance and techniques used in gene analysis. The evolutionary, social, ethical, and legal issues associated with knowledge of the human genome will be discussed.

CMPS2: Computer Literacy
Introduction to how computers work and how to use them. Topics covered include network information systems, text editors, formatting, file and directory system, spreadsheets and databases. Computers as symbol manipulation devices. Introduction to programming concepts and computer languages. Impact of computers on society. Designed for students with little or no experience using computers. Preference is given to students who have not taken other computer engineering or computer science courses.

CMPS80J: Technology Targeted at Social Issues
Introduces the idea that engineering can be a means for addressing social issues. Case studies and guest speakers. Issues might include: economic development, privacy, activism, safe drinking water, inexpensive shelters, sustainable energy, education, and waste disposal.

CMPE3: Personal Computer Concepts: Software and Hardware
Provides an introduction to computers. Personal computing is emphasized, and students are introduced to word processing, spreadsheets, database management, graphics, and programming. Covers fundamentals of computing and current and future uses of computer technology, PC hardware, Windows operating system, applications software, networking and the Internet, and developments in the computer industry. Designed for students with little or no experience using computers.

CMPE80A: Universal Access: Disability, Technology, and Society
Overview of human-centered technology and of its potential for increasing the quality of life and independence of disabled individuals. A substantial portion of the course is devoted to studying physical, psychological, and psychosocial aspects of disability. Topics include: diversity and integration, legislation, accessibility, and universal design.

EE80J: Renewable Energy Sources
Introduction to energy storage conversion with special emphasis on renewable sources. Fundamental energy conversion limits based on physics and existing material properties. Various sources, such as solar, wind, hydropower, geothermal, and fuel cells described. Cost-benefit analysis of different alternative sources performed, and key roadblocks for large-scale implementation examined. Latest research on solar cells and applications of nanotechnology on energy conversion and storage introduced.

EE80T: Modern Electronic Technology and How It Works
Basic knowledge of electricity and "how things work," how technology evolves, its impact on society and history, and basic technical literacy for the non-specialist. Broad overview of professional aspects of engineering and introduction and overview of basic systems and components. Topics include electrical power, radio, television, radar, computers, robots, telecommunications, and the Internet.

CMPS80J: Technology Targeted at Social Issues
Introduces the idea that engineering can be a means for addressing social issues. Case studies and guest speakers. Issues might include: economic development, privacy, activism, safe drinking water, inexpensive shelters, sustainable energy, education, and waste disposal.

CMPS80S: From Software Innovation to Social Entrepreneurship
Emerging software innovations with emphasis on social software. Web 2.0 companies and services. Software that has social impact in a global context. Entrepreneurial plan including social, economic, and innovation value. Final group project on innovative software design and entrepreneurship plan.

4. Should there be an Engineering general education SA Breadth category distinct from Natural Sciences, reflecting *distinct educational objectives*? Or should there be one Natural Sciences & Engineering category? Why? If you advocate for a distinction, your answer to “why” needs to help future course approval committees decide whether a proposed course is best classified as “Natural Sciences” or “Engineering”.

We believe there should be a distinct SA Breadth category for Engineering. By traditional measures, engineering at UCSC is limited in scope, nevertheless, the aspects of engineering, we do teach and study (bio/info/nano) have direct and significant impacts on nearly every aspect of our students lives and future careers. For this reason we believe it is appropriate that engineering and technology be distinct from the Natural Sciences. At the same time, we think it is important to not increase the number of general education requirements for our students. We adhere to the belief that breadth need not sample every area but should include some exploration *outside of a student's primary discipline. We would therefore suggest that the number of SA Breadth categories that must be covered by a student remain at four (3 outside of the students primary area) or keep the current suggestion of 7 SA Breadth courses, with the restriction that at most two be from any one area.*

5. If you advocate for separate categories, do you think that there should be an equal number of required courses in Natural Sciences and Engineering? Why or why not? Whether or not your answer is influenced by divisional resource or territorial considerations, please also address the educational rationale.

As mentioned in our response to question 4, we adhere to the philosophy that breadth need not be comprehensive. We believe the maximum number of courses taken in Engineering that contribute to satisfying the SA Breadth requirement should be the same as that for other areas, and two seems like a reasonable number. As stated above, students might satisfy the GE requirement by taking fewer than two courses in one or even two areas, depending upon the final formulation of the SA Breadth requirement.

We will end by stating that these are answers to very specific questions. Please do not construe our answers as either agreement or disagreement on the general proposal. There have been some discussions that would result in somewhat different GE plans, largely surrounding the question of how much breadth should be required?

For example, here is an alternative view expressed by one SOE faculty member:

> *The problem I see with [the current proposal] is that students could graduate without a course requiring them to consider the implications of genetics or evolution, or even to take a science course at all. I would rather each student take a course in biological sciences that required rudimentary knowledge of genetics/evolution and another that required rudimentary knowledge of Newtonian Physics and conservation laws. (A robotics course may be an example of the later). And if there were room for a third course, [add] one on technology. But I would not eliminate a biology or conceptual physics for a course on technology unless there was something about biology or physics in the technology course.*
>
> *My opinion is that we need citizens that understand science and technology at a level that they can vote as informed citizens in our technological world. With that premise I would insist on a biological science that requires an understanding of evolution to do that science, and a science or engineering course that is physics based, and possibly a course on how technology works which may involve introductory programming or something like CMPS2/CMPE3, or some of the engineering 80 courses if they adequately convey technology. As you can see, I do not insist that every student should take X engineering courses "just because" they take X Humanities or Social Sciences or Science courses.*