University of California, Merced
School of Engineering
Three-Year Strategic Plan (SP2012-15)

1. Introduction and Mission

The mission of the School of Engineering at University of California, Merced is to change the region and the world through its research and through those it educates and serves. Our highest priority is to create an intellectual and physical environment for research and education that makes us a magnet for creative faculty, staff, and students who will collectively have a transformational impact. This document presents the strategic plan for the School and details how we plan to realize our potential as a leader in engineering and interdisciplinary research.

A key milestone will be a School that fills its crucial role in a globally-competitive and regionally-relevant research university of nominally 10,000 students in 2020. We are certain that engineering and other STEM disciplines will be the foundation on which UCM elevates the region and state. Even if we grow to a point of having an exceptional fraction of UCM's students, our faculty numbers will still be considerably lower than our aspirational peers. In order to continue to compete with these peers, for which a large and multi-disciplinary faculty is generally a central tenet, the School must exploit its small size by integrating our activities with those of the rest of the University. In order for UC Merced realize its promise to California, the SoE faculty must grow in size from a headcount of 34 ladder rank faculty (31.5 FTE accounting for joint appointments and subtracting 2 appointed in Management program) to approximately 80 ladder rank faculty, in part through joint appointments with other Schools in areas of mutual interest. In that timeframe we will have developed plans to integrate Civil and Electrical Engineering majors into Environmental Sciences and Computer Science, a step we deem necessary to take the next step. This approach is well timed as research in the sciences becomes more technology based, allowing Merced to be on the cutting edge of applying engineering methodologies to scientific frontiers and economic development. We will do so by building on our disciplinary strengths and leveraging our interdisciplinary focus, sustainability vision, diversity, and service mindset. The hallmarks of our undergraduate students will be their training in innovation, sustainability and engagement.

- **Interdisciplinary Research**

Innovative research ideas generally transcend the scope of a single discipline. Interdisciplinary research provides a "format and connections that can lead to new knowledge."[1] Interdisciplinary graduate groups/programs are a hallmark of UC Merced. The SoE faculty self-organized in interdisciplinary graduate groups/programs, aligning their research interests with the school's educational programs

1

Committee on Facilitating Interdisciplinary Research, National Academy of Sciences, National Academy of Engineering, Institute of Medicine, *Facilitating Interdisciplinary Research***, 2004, ISBN:** 978-0-309-09435-1, 332 pages


Vision: UCM SoE, through its research and those it educates, will change the region and the world
Strategy: Leverage our interdisciplinary focus, sustainability vision, diversity, & service mindset
Innovation
•High-impact Research
•Knowledge and Drive
•Integration and Problem Solving
•Creative & Rigorous Design
•Entrepreneurship
Sustainability
•Fundamentals
•Teams/Partnerships
•Imagination
•Communication
•Ethics
•Economic, Environmental, Social
Engagement
•Signature Initiatives of Region/Global Impact
•Resource Sharing
•Global Solutions
•Adaptability
•Continuous Learning
•Values & Social Impact
Technology Innovation and Entrepreneurship Ecosystem
San Joaquin Valley Economic Development

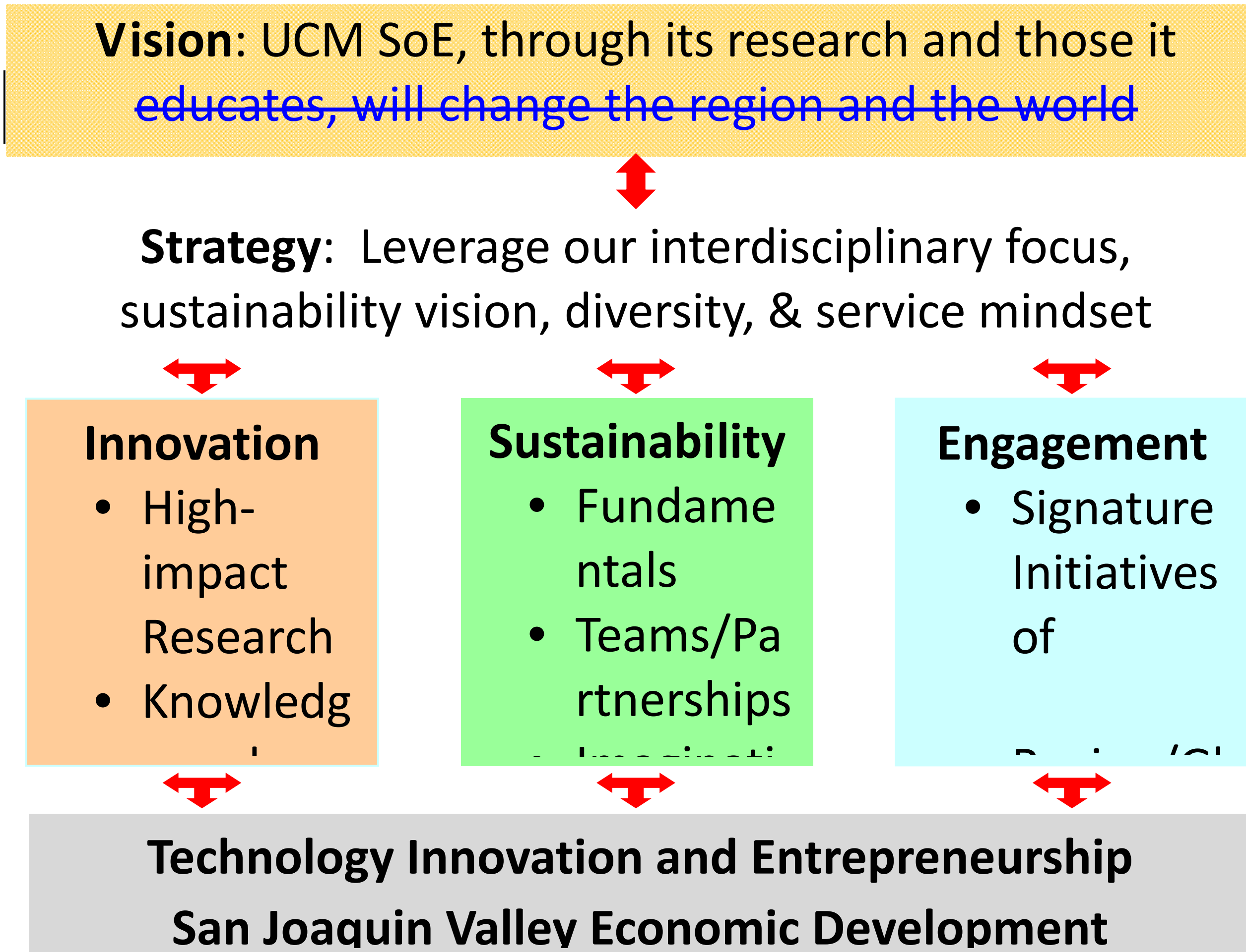

Figure 1. Guiding Strategy for the School of Engineering Strategic Plan.

(six disciplinary undergraduate degree programs: Bioengineering, Computer Science and Engineering, Environmental Engineering, Materials Science and Engineering and Mechanical Engineering). SoE oversees four interdisciplinary graduate groups/programs (Bioengineering and Small-Scale Technologies (BEST), Environmental Systems (ES), Mechanical Engineering and Applied Mechanics (MEAM) and Electrical Engineering and Computer Science (EECS)); our principle research areas are: 1) Environmental Systems, 2) Thermo-Mechanical Systems, 3) Biomedical-Inspired Technologies, and 4) Intelligent Systems. Sustainability is woven throughout our programs and is reflected in the proposed faculty hires. Nearly every hire has the potential to span graduate groups and undergraduate majors. Engineering has demonstrated its ability not only to span graduate groups, but to support faculty members whose interdisciplinary research spans schools. We have two faculty who have (and are currently being considered for) tenure who are cross-school hires at the assistant level with SSHA, another coming up for promotion to full professor. We also have two senior faculty members who have cross-school hires with SNS. A fifth emphasis area: Technology Management has been initiated by the hire of two new faculty members, one of whom is negotiating a cross-school appointment with SSHA. Based on these successful cases, we anticipate that Engineering will continue to fully embrace interdisciplinary research.

- **Innovative Undergraduate Program: Learning & Service with a Sustainability theme**

The Engineering program prepares students for careers in academia, industry and government agencies. A hallmark of our program will be how faculty in this program swiftly, but thoughtfully, engage with new innovations and information technologies that will revolutionize how we communicate, who we teach, and what data we access. Integrated into all teaching and service activities is the common theme of sustainability. Faculty and students in this program are continually asking how they can meet current needs without compromising our ability to meet the future needs. Our projects involve consideration of a diversity of large scale societal questions, e.g. renewable energy sources, robotics, innovative materials and water supplies. This shared theme enhances connections with other researchers and teachers who are driven to address the grand challenge of sustainable development. The Engineering program leverages research and teaching to serve San Joaquin Valley and California. Faculty in the program mentor interdisciplinary student groups in engineering service learning projects that directly benefit the environmental sustainability goals of regional community organizations. The program is based on a culture that embraces the extraordinary diversity of our students and prepares these students to provide the future of engineering and scientific leadership in the San Joaquin Valley and beyond.

This plan was formed by the SoE Resources Committee by synthesizing 1) input obtained during formal faculty meetings, 2) information obtained from relevant faculty groups research institutes and graduate groups, and 3) document exchange-review cycles that occurred from January through April 4, 2012. The Appendices attached to this document are all updated to reflect the current vision for our program and are reflected in our current resource request.

2. Proposed Goals

2.1. Research Excellence

Publish high-impact studies in leading peer-reviewed journals and establish interdisciplinary studies.

The EECS graduate group, while small, numbering only 7.5 research FTEs, and comprised of mostly assistant professors, has already achieved research excellence based on a number of metrics. Faculty in the group are the recipients of three NSF Faculty Early Career Development (CAREER) Awards, a DOE Early Career Scientist and Engineer Award, and a Presidential Early Career Award for Scientists and Engineers (PECASE). The faculty also serve on the editorial boards of a number of top journals in their respective areas including the IEEE Transactions on Pattern Analysis and Machine Intelligence, the IEEE Transactions on Robotics, and the ACM Transactions on Sensor Networks.

EnvE faculty, predominantly associated with the Environmental Systems graduate group, research areas that span biofuels, solar energy, market-based environmental solutions, and effects of a changing climate on forests and water. Multi-disciplinary research programs include an NSF-funded Critical Zone Observatory to study mountain hydrology, ecology and geochemistry, supplemented by a larger-scale, NSF-funded American River Observatory, both efforts led by Bales. Westerling has published a number of high-impact papers on climate-wildfire links, Campbell has published a series of high-profile papers on life-cycle implications of various bioenergy alternatives. ES faculties pride themselves on the societal relevance of their research, and have good ties with the resource-management community to translate research findings into decision making. Examples of successful ties include the Sierra Adaptive Management Project, and (Bales, Conklin and Guo), funded by USDA Forest Service and CA Dept of Water Resources, and related projects supported by these and other agencies in the region, and the

Gridded Seasonal Wildfire Outlook project (Westerling, funded by the National Wildfire Coordinating Group via the USDA Forest Service).

The faculty members of the MEAM graduate group have excellent research track records and international reputations in their respective areas. They serve as editors and editorial board members of prestigious journals and book series. The group has established a strong presence in the following research areas: Renewable Energy Conversion, Electrochemical Energy Conversion and Storage, Global Engineering Education, Design and Innovation, Tribology, Optical sensors for manufacturing, Radiative Heat Transfer, Heat Transfer in Combustion, Multi-scale and Multi-physics Flow, Microelectronic Cooling, Vibration and Noise Control, and Nonlinear Stochastic Systems.

BEST faculty have demonstrated research excellence on many fronts. Notable achievements include a DARPA Young Faculty Award, a First Place Award in the Innovation Category at the 2010 national Faculty Workshop (MIT), invited participation in a National Academy of Engineering Annual U.S. Frontiers of Engineering Symposium. Faculty productivity is demonstrated by numerous invention disclosures, and publications in top-flight journals (Nano Letters, Advanced Materials, Nature Nanotech, PNAS, JACS, Advanced Energy Materials, and Philosophical Transaction of the Royal Society). Faculty research has been featured on the cover of Advanced Energy Materials (twice) and in two National Geographic Society documentaries.

Earn research funding from competitive solicitations. The SoE faculty continues to compete effectively for extramural support and the development of interdisciplinary and disciplinary research programs. Over the last couple of years, SoE faculty have been responsible for up to $2.4M per month of extramural funding, roughly 50 to 90% of the total campus award funding in a given month.

The SoE intends to improve upon this impressive effort in terms of both extramural funding and graduate student enrollment, both of which are a function of faculty size. Thus, additional FTEs are proposed in research areas that are either highly complementary to existing research strengths and increase multi-disciplinary research opportunities. Although SoE investigators are extremely space-limited, they remain highly productive in terms of sponsored research. In the last academic year, SoE faculty have exceeded $5.1M in awards. In addition, establishment of new interdisciplinary research centers is also expected to increase funding levels. However, it is important to note that space limitations in the near term may temper these affects.

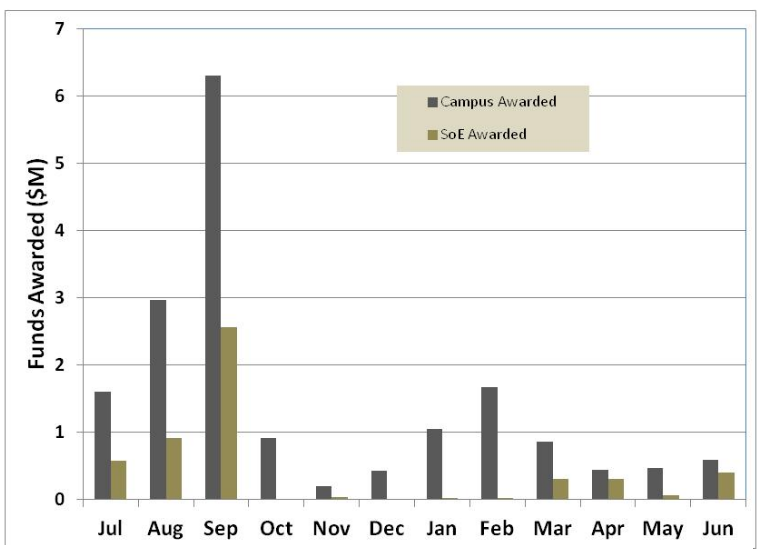

Figure 2. SoE research funding Jul 2010-June 2011

Provide leadership of cross-disciplinary research initiatives. Interdisciplinary research and educational programs are central to the overall development of the UC Merced campus. Faculty in EECS and CIS have established the *Center for Autonomous and Interactive*

Systems (CAIS) and faculty in EECS and EnvE along with a faculty member in History in SSHA have established the *Spatial Analysis and Research Center (SpARC)*. Both centers contribute to the Intelligent Systems thrust and are highly interdiscplinary, involving cross-displinary collaborations between faculty in SoE as well as faculty in the other two schools at UC Merced. Over the next three years, EnvE and MS faculty will provide the leadership in establishing the interdisciplinary *Center for Sustainable Systems Science, Engineering and Management.*

2.2. Develop thriving interdisciplinary graduate programs

Commensurate with the achieved research funding, the SoE faculty is also responsible for a significant fraction of the graduate student population, about 100 of the 260 graduate students are affiliated with engineering faculty. To provide an intellectually stimulating environment for graduate education and mentoring SoE faculty will strive for a mix of graduate students and postdoctoral fellows. Our goal is that each faculty member supervises an average of 3 PhD students/Postdoctoral fellows in the next 3 years. Our goal by 2020 is to have 4 PhD students/faculty; that would result in a graduate student population of 320 (16% of the targeted student population of 2000). In addition, in our resource request, we have stressed hiring faculty capable of teaching in impacted areas (majors with student to faculty rations greater than 25:1), so that faculty in these areas can offer graduate courses. We are also hiring a lecturer with security of employment (LSOE) this year and in 2013 to help cover the teaching of fundamental courses, to free up faculty to teach in their areas of expertise and expand graduate offerings.

2.3. Undergraduate Program and ABET accreditation

Engineering majors remain popular at Merced, with several of the largest majors on campus being Mechanical Engineering (ME, 4^{th} largest), Computer Science Engineering (CSE, 5^{th}), and Bioengineering (BioE, 8^{th}). We anticipate that these majors will continue to show strong enrollments. Our main short-term undergraduate educational focus in the SoE is to (1) stabilize the curriculum in a sustainable manner to make short-term accreditation (ABET) feasible for three degree programs, Mechanical Engineering, Environmental Engineering and Material Science and Engineering, and (2) positioning ourselves for enrollment growth through modification of existing majors by expansion of course offerings**.** With a focus area of air pollution and energy, EnvE is planning to become Environmental and Sustainable Engineering within 3 years. If one does an analysis of thriving undergraduate programs in engineering tone finds a common thread of three majors: ME, Electrical Engineering (EE) and Civil Engineering (CE). We do recognize the need for adding both EE and CE to our curriculum. We plan to sequence these, by initially, recruiting EE faculty into the EECS group and charge them with creating an "emphasis area" within the existing CSE major. As the EE emphasis becomes more evident, we may decide to modify this major's name. Only when we have a sufficient faculty (at least six) to support it, we will modify the major name to include EE in the degree name. To implement this plan we need to hire an average of two EE faculty a year over the next three years. As these hires will not advance our goal of having a student to faculty ratio of 25:1, we have listed these positions as a secondary request to build a major (Table 2). Developing a Civil Engineering degree program has significant resource needs (particularly in laboratory infrastructure). Over the next few years, we will develop a strategic plan for the development of CE program incubated in EnvE; our vision is a CE program based on sustainable infrastructure engineering, rather than the traditional CE program. The growth of the CE program is sequenced to follow the EE degree. Given the budget constraints of UC Merced, we will craft this in terms of major naming gift opportunities to attract a significant portion of the start-up and operating costs of these programs.

3. Resource Needs

To support the ambitious research and educational goals outlined above, additional FTEs in the form of regular faculty and lecturers will be needed. Given the near term resource constraints, recruitment must be highly strategic. All our goals are reflected in our request for FTEs. We have put an emphasis on choosing areas that complement and expand graduate groups, while providing faculty with the expertise to teach disciplinary undergraduate courses. We have a major BioE that have student to faculty ratios greater than 50:1, a second major ME with greater that 40:1, and a third major, CSE is 27:1. We have emphasized building up these majors and graduate groups. Strategic hires, such as air pollution and ecological engineering will provide research synergies that expand the depth of the ES graduate group and provide synergies with other schools (see Table 1). As mentioned above, we request faculty lines to launch the EE major (see Table 2.) Some of the proposed hires, e.g. the Biomedical Imaging, will have strong synergies with EE.

In addition to SoE FTE recruitment, and in order to enhance SoE synergy with other academic and research units, particularly the Merced management program, we propose the cross-unit hires summarized in Table 3. The first cross-school hire, sustainable building appears in multiple disciplinary strategic plans. The second two hires, Virtual Environments and Media Arts & Technology build on the strong relationship between CSEE and CIS and would provide an excellent platform to integrate proposed EE FTEs.

The FTE recruitment plan proposed by the SoE over the next three years includes 15 faculty members into existing programs, 3 cross-school positions, and 1 lecturer. In addition, we have added a request for 6 FTE to build the EE program. This will result in 25 faculty and lecturers. We request that all faculty searches be open rank, to allow us the ability to recruit the most qualified individual. Given our emphasis on interdisciplinary and sustainability, we seek faculty with a proven record of being innovative in their research programs.

Table 1. Summary of FTE Requests by the School of Engineering for the next three AYs.

Position	Graduate Research Program(s)[2]	Undergraduate Program(s)[3]
	AY 2012-2013	
SoE-1. Stochastic Modeling	MEAM primary, ES secondary	ME/EnvE
SoE-2. Computer Science Theory	EECS primary, AMGS secondary	CSE
SoE-3. Physiological/biochemical Modeling	BEST primary, EECS secondary	BioE/CSE
SoE-4. Recombinant Sensor Develop	BEST primary, EECS secondary	BioE/CSE/EE
	AY 2013-2014	
SoE-5. Fundamental Lect.		ENGR
SoE-6. Intelligent & Adaptive Control	EECS primary, MEAM secondary	CSE/ME
SoE-7. Multi-scale Solid Mechanics	MEAM primary, ES secondary	ME/EnvE
SoE-8. Complex Flow	MEAM primary, ES secondary	ME/EnvE
SoE-9. Air Pollution Modeling	ES primary, MEAM secondary	EnvE/ME
SoE-10. Translational Bio-Engineering	BEST primary	BioE/MSE
	AY 2014-2015	
SoE-11. Computer Systems	EECS primary, MEAM secondary	CSE/ME
SoE-12. Computer Security	EECS primary, AMGS secondary	CSE
SoE-13. Bio-control	MEAM primary, BEST secondary	ME/BioE
SoE-14. Energy Transport and Conversion	MEAM primary, ES secondary	ME/ EnvE
SoE-15. Biomedical Imaging	BEST primary, EECS secondary	BioE/CSE
SoE-16. Ecological Engineering	ES primary, BEST secondary	EnvE/BioE

Table 2. Proposed EE positions for the upcoming three AYs.

Position	Graduate Research Program(s)[4]	Undergraduate Program(s)[5]
	AY 2012-2013	
SoE-1. Signal Processing	EECS primary	EE, CSE
SoE-2. Computer Architecture	EECS primary	EE, CSE
	AY 2013-2014	
SoE-3. Circuit Design	EECS primary	EE, CSE
SoE-4. Semiconductor	EECS primary	EE, CSE, MSE
	AY 2014-2015	
SoE-5. Communications	EECS primary	EE, CSE

[2] Recommended search committee to include primary (chair) and secondary graduate group or institute representations.

[3] Undergraduate teaching assignments will be in areas of greatest need at the time of the hire.

[4] Recommended search committee to include primary (chair) and secondary graduate group or institute representations.

[5] Undergraduate teaching assignments will be in areas of greatest need at the time of the hire.

SoE-6. Information Theory	EECS primary	EE, CSE

Table 3. Proposed cross-unit positions for the upcoming three AYs.

Position	Graduate Research Program(s)	Undergraduate Program(s)
	AY 2012-2015	
Cross 1. Sustainable Building	MEAM, ES, BEST, Mgmt	ME/EnvE/MSE/
Cross 2. Virtual Environments	EECS, CIS	CSE/COGS
Cross 3. Media Arts & Technology	EECS, CIS, World Cultures	CSE, ARTS

Appendix: Program-Specific Vision, Goals, and Rationale for FTE Requests

Electrical Engineering and Computer Science (EECS) Three-Year Strategic Plan (SP2012-15)

EECS Overview - The EECS faculty offer a popular undergraduate major in Computer Science & Engineering (CSE), as well as graduate degrees under the EECS. EECS faculty members have diverse research interests with areas of investigation in artificial intelligence, computational neuroscience, computer animation and graphics, computer vision, machine learning, image and speech processing, robotics, and distributed networked systems. These research themes frequently share a focus on ***intelligent systems***, and this focus has been consciously adopted by the group to build research excellence in a specific intellectual area. The EECS faculty regularly collaborate with colleagues in other fields across the Merced campus, contributing to interdisciplinary work in computational biology, environmental systems, and cognitive science. Indeed, the group has a strong bond to the CIS program, with several funded research projects spanning this cross-campus gap. The EECS program is critical to the success of Merced, playing a central role in implementing the campus' strategic focus on "Cognitive Science and Intelligent Systems", as highlighted in its *Strategic Academic Vision* document.

EECS Teaching Programs – The undergraduate CSE major is designed to provide students with both breadth and depth in the exciting and rapidly expanding fields of: *Computer Science* - the study of computation, including algorithms and data structures, and *Computer Engineering* - including hardware, software and network architecture. CSE is the 5th largest major on campus with an enrollment of 230 in AY 2011-2012. Given awareness of and demand for this major, undergraduate enrollment is expected to continue to grow as long as space and faculty are added to the program. From this perspective, it will soon become important to examine the tradeoff between increase in enrollment and selectivity for this program.

Description of Requested Faculty Positions

The EECS program requests that resources be promptly allocated to replace a vacated junior faculty position and that three new tenure-track faculty positions be opened over the course of the next three years. The plan outlined here proposes that these positions be created at a rate of one per year.

Replacement Tenure-Track Faculty Position

Intelligent & Adaptive Control

At the onset of the 2009–2010 academic year the EECS program lost an important member of its faculty. Songhwai Oh, an expert in intelligent systems, opted to resign from his position at the University of California, Merced, for personal reasons. The absence of Dr. Oh has introduced substantial hardship for the EECS faculty. Without his teaching contributions to the Computer Science & Engineering (CSE) undergraduate program, the faculty have been strained to offer a sufficient number of upper division elective courses to allow CSE majors to graduate in a timely manner. This problem was particularly evident in the spring of 2010, when many seniors with hopes of a immanent graduation were left scrambling to find courses that satisfied their remaining major requirements. The departure of Dr. Oh has also impacted the EECS graduate education program, reducing the number and range of available graduate courses and eliminating an important source of mentorship for the sizeable fraction of our Ph.D. students whose work involves intelligent systems. In short, the loss of Dr. Oh has introduced a giant step backwards in efforts to deliver a quality undergraduate program and to establish a CCGA certified EECS graduate group.

In order to address this loss, we propose the creation of a replacement faculty position at the Assistant Professor level focusing on **Intelligent & Adaptive Control**, with the search for this position starting no later than 2012–2013. The successful candidate for this position will conduct research on the design and analysis of control systems, making use of methods from artificial intelligence, control theory, cybernetics, machine learning, and/or robotics. Potential application areas include, but are not limited to: active sensing, environmental control, intelligent transportation systems, mechatronics, power management, & robotics. The EECS strategic plan cites this position as important for building a strong international reputation in one of the program's primary focus areas: intelligent systems. In addition to supporting the EECS graduate curriculum, speeding CCGA approval of the EECS graduate program, building in this area supports the campus-wide focus on "Cognitive Science and Intelligent Systems", as highlighted in the *Strategic Academic Vision* of the University of California, Merced. It is also worth noting that, since the field of control theory traditionally spans computer science, electrical engineering, and mechanical engineering, there is good reason to expect this position to additionally support the mechanical engineering programs in the School of Engineering.

New Tenure-Track Faculty Positions

Computer Science Theory

The EECS faculty propose the creation of a new faculty position at the Assistant Professor level focusing on **Computer Science Theory**, with the search for this position starting no later than the 2012–2013 academic year for a start date of summer/fall 2013. The successful candidate for this position will conduct research in the mathematical foundations of computation. Potential research areas include, but are not limited to: computational complexity, computational game theory, computational geometry, computational learning theory, cryptography, security, networking theory, automatic theorem proving, automated system verification, numeric optimization, & numerical analysis. The EECS strategic plan cites this position as critical for establishing international respect as a leading computer science program, for contributing to a graduate program core curriculum, and for providing foundational courses for the CSE undergraduate program. Furthermore, during this period of fiscal constraint, it would be wise to leverage the fact that mathematical theorists of this kind typically require relatively little in the way of space and equipment resources.

Computer Systems

The EECS faculty propose the creation of a new faculty position at the Assistant Professor level focusing on **Computer Systems**, with the search for this position starting no later than the 2013–2014 academic year for a start date of summer/fall 2014. The successful candidate for this position will conduct research related to the design and analysis of complex computer systems. Potential research areas include, but are not limited to: computer architecture, distributed sensing and monitoring, mobile computing, networking, operating systems, programming languages, software engineering, automated system verification, privacy and security, & ubiquitous computing. The EECS strategic plan cites this position as critical for establishing international respect as a leading computer science program, for constructing the foundation of a graduate program core curriculum, and, thus, for meeting the demands of CCGA certification as a graduate group. In addition to supporting EECS program needs, this position will likely produce fruitful cross-campus collaborations, though the nature of these collaborations is difficult to predict, given the ubiquity of complex computer systems in virtually every contemporary field of inquiry. While laboratory space needs can vary widely among computer systems researchers, candidates who focus on software solutions are expected to require relatively small labs.

Computer Security

The EECS faculty propose the creation of a new faculty position at the Assistant Professor level focusing on **Computer Security**, with the search for this position starting no later than the 2014–2015 academic year for a start date of summer/fall 2015. The successful candidate for this position will conduct research in areas including, but not limited to: design and formal verification of security protocols, programs, and architectures; cryptography; network and operating systems security; web security; privacy enhancing technologies in a broad sense, privacy in data acquisition, processing, and publishing; reliability, accountability and trust; security and privacy in decentralized systems; as well cross-cutting disciplines such as usability and social aspects in this research field.

Lecturers

In addition to the tenure-track research faculty positions outlined in this document, the EECS faculty request the continued support of 2–3 Lecturer positions associated with the CSE major, with one of these positions providing Potential Security of Employment (LPSOE). The EECS program provides lower division courses on computer programming, both as part of the CSE curriculum and as a service to the full range of engineering majors, who are required to complete several of these courses, as well as to students in the other schools. These courses currently include CSE 5 (for non-engineers), CSE 20/21 (required for all engineering majors), and CSE 30/31 (required for CSE majors). These courses typically have high enrollment, must be offered frequently including during summer, and place high demands on the time of instructors.

Justification for Prioritization

The order of three new tenure track positions requested by the EECS faculty at a rate of one per year is determined first by space constraints—the highest priority request in Computer Science Theory requires the least amount of lab space—and by need—Computer Systems is an important subfield of computer science in which we currently are underrepresented.

In summary, in order to meet the goals of the EECS strategic plan, the EECS faculty must grow beyond its current size and composition, and increasing the rate of growth will only speed progress toward these goals. It should be noted, however, that slowing the growth of this program below the level outlined in this plan will be sure to:

• Further slow progress toward the development of a CCGA approved graduate degree program in EECS.
• Further slow progress toward an internationally respected undergraduate CSE degree.
• Further slow progress toward establishing the University of California at Merced as a leader.

For this reason, we strongly recommend the creation of at least one EECS tenure-track faculty position per year for the next three years.

Bioengineering

Bioengineering Overview - Bioengineering is a highly interdisciplinary field in which the techniques, devices, materials and resourcefulness of engineers are used to address problems in biology and healthcare; and lessons from biology are used to inspire design and inform progress in engineering. During the past 40 years, this synergy between biology and engineering has led to a wide range of implantable materials, diagnostic devices, sensors and molecular characterization techniques, and it has produced tools that greatly expedited the sequencing of the human genome. Along with these practical innovations has come a rapidly increasing need for personnel with the necessary hybrid skills to capitalize on them; undergraduate bioengineering programs have proliferated alongside the continued growth of bioengineering research.

The current bioengineering faculty members are affiliated with the **BEST** and **QSB** graduate programs. The faculty constitutes a strong research core which, with a few additions, can develop into a nationally competitive research cluster. The current faculty members have a wide range of expertise in physiological engineering, tissue engineering, regenerative medicine, biophysics, etc. The BioE faculty is committed to expand the research scope in the major to complement the research area of the current faculty.

The undergraduate major in **Bioengineering (BioE)** is designed to provide students with both breadth and depth in two exciting and rapidly expanding fields: tissue engineering and nano-bioengineering. The nano-bioengineering track reflects the strong synergy that exists between the "nano" and "bio" themes in engineering and science. The name also highlights an initial focus on things molecular, supramolecular, cellular and material, which will allow the program to draw efficiently on the talents of the biologists, chemists, physicists and other UC Merced faculty in basic engineering and science programs.

BioE Teaching Programs – Currently BioE program has only three faculty members. It is extremely difficult to deliver a major and a graduate program (BEST) with such few people. A consolidation effort has been made to prioritize the class offering in BioE. The plan will reduce the total required credits and incorporate electives from other areas (e.g., Mechanical and Materials Science Engineering) to maintain their undergraduate major while continuing to develop their graduate research program.

BioE Goals
BioE Research Goals – The research goal for BioE program is to maintain high level of federal and national funding as well as to publish peer-reviewed research articles in reputational journals.
BioE Teaching Goals – Bioengineering is a field including expertise in areas such as drug delivery, tissue engineering, medical imaging, physiological modeling, molecular engineering, biomechanics, bioinstrumentation and medical device developments. With sufficient faculty available, more diverse courses can be offered to undergraduate and graduate students in order to provide a comprehensive and broad bioengineering education experience. The teaching goals will be the program learning outcomes of the BIOE major reflect seven of UC Merced's eight guiding principles of general education.
BioE Current Academic Resources – One full professor and two assistant professors. BioE program currently has wet lab around 1.5 suites in SE1 building.
BioE Envisioned Program by 2020 – We envision BioE Program will have 7 to 9 faculty members. The number of undergraduate program will be around 150 to 200. We expect to have 20 to 25 graduate students in the BEST program.

BioE Resource Requirements 2011 – 2016 – More faculty members (3 more) are needed for BioE program to maintain its standard in teaching quality and research excellence. Appropriate space allocation (both wet and dry lab) will be beneficial for the recruiting of these additional faculty members.

BioE Academic (FTEs) Requests
To deliver the BIOE undergraduate program, 26 program specific credits have to be offered. These credits do not include engineering fundamentals courses, service learning, freshman seminars, or graduate courses. They also do not allow for multiple offerings of any course in an academic year.

BIOE has currently only 3 existing faculty positions that cannot realistically deliver 26 BIOE related credits (lecture and laboratory courses) in the foreseeable future. Using a model in which a faculty member would typically offer one fundamental/core course, one specialist/upper division course or one graduate course in a year (plus a freshman seminar and/or mentor a service learning team), it is clear that BIOE does not have the minimum number of faculty FTEs to deliver the major. In addition, BIOE is part of BEST (Biological Engineering and Small-scale Technology) graduate group and has to cover two required graduate courses and sufficient advanced elective classes (3-5) for BEST students.
Given the current limitation due to the economical recession, a minimum of three FTE are urgently needed as identified by the faculty in BIOE (listed in the priority order):

• **Physiological/Biochemical Modeling (SoE-X) -** We have been experiencing unprecedented advances into the complex nature of biological systems in recent years. Current advances in biology, genomics, proteomics, cellular level modeling methods, simulation capabilities, new technologies for imaging and measuring biological phenomena and molecular level interfacial characterization tools present the engineering community with unique opportunities to advance the understanding of these biological or even ecological systems to deliver desired functions. Currently the lack of involvement of engineering has hindered the complete understanding of the complex biological systems. Furthermore, there is a need to understand how the desired or additional functionality can eventually be accomplished and integrated over larger scales and complexities from cellular, organism to ecosystem level. Systematic modeling incorporating various engineering concepts such as optimization, database management, control and network formation based on large body of experimental results would lead to complete understanding of the non-linear nature of biological systems. Being an interdisciplinary field between engineering and biology, BioE has a strategic advantage in engineering to address this unique challenge and opportunity.

Current the faculty members in bioengineering at Merced are experimentally oriented researchers. Modeling expertise at multiple levels is needed to tackle more complex biological projects. This requested multiple-scale modeling position will be at junior (assistant professor) level. This faculty member is expected to collaborate with the current faculty members to link various research areas to study specific biological/physiological problems from system point of view. This position will develop quantitative modeling and simulation methods that faithfully represent the complexity of biological/ physiological systems based on experimental data and deal creatively with the hierarchical and nonlinear nature of living systems. This position will integrative knowledge from various research fields to serve a focal point for faculty members from NS, ME and BIOE to collaborate on projects that cannot be addressed from the view point of a single discipline.

• **Recombinant Sensor Development (SoE X) –** Recombinant protein sensor development has made tremendous progress in recent years. Various protein sensors that report wide range of physiological and biochemical information inside cells have been created. These protein sensors exhibit many different spectral characteristics depending on the need of the application. The area of recombinant sensor development is, by nature, cross disciplinary in that it employs cell culture methods combined with appropriate organic chemistry, biophysics, molecular biology, genetic engineering, non-linear optics as well as nano-bioengineering. Moreover, this sensors can be genetically engineered in animals or gene delivered by electroporation or adenoviral transfection.

The Recombinant Sensor Development position could also compliment and synergize with the research of a number of faculty in the areas of Biophysics, Physiological Engineering, Stem Cells, Vascular Tissue Engineering, Nanotechnology, and Microfluidics/Microchip design. We expect that this faculty hire would contribute to our growing graduate program in BEST and Quantitative and Systems Biology Depending the particular area of research, this faculty position could possibly contribute to helping build a Stem Cell Clean Room Facility at MERCED. We propose this position to be appointed at senior level (Associate or above).

• **Translational Bioengineering (SoE) (2012-2013)-** We request a senior faculty position (Associate-Full professor) to be in the area of **Translational Bioengineering**. Translational bioengineering research refers to the transformation of scientific discoveries into practical solutions. Specifically, to develop medical technology that will help people live longer and more comfortably.To increase the chances of success, creative teamwork across disciplines is essential. Biomedical researchers engage in translational research when they focus on developing solutions that address particular clinical problems or unmet clinical needs. Translational research is currently a priority of the National Institutes of Health and other funding agencies and foundations. This is an important component in bioengineering (or biomedical engineering) education, and should be included in our program. Currently, we do not have any faculty member with this expertise. This position will complement the research area in the coming EE program and so promote synergy between BIOE, MSE, ME and EE. There will also be opportunities for a BioMEM colleague to synergize with efforts in Computer Sciences and the human health focus area of Natural Sciences.
The space need for this translational Bioengineering hire will be mainly for wet lab space, estimated to be similar to the estimated requirement of 400 square feet for previous BioE hires. Access to (shared, if appropriate) computing facilities and limited dry lab space might also be needed.

Medical Imaging (SoE) (2013-2014)- Recent developments in optical/imaging techniques (such as ultrasound, MRI, PET, CT) clearly indicate the enormous potential of Medical Imaging in clinical applications. The imaging sciences are in the midst of a profound revolution that stems from new and fundamental advances in imaging, tissue engineering, biophysics, physiology and molecular and cellular biology. This is due in large part to the new technology and quantitative approaches developed in the disciplines of chemistry, physics and engineering. Due to its highly multidisciplinary nature, Medical Imaging technology presents a unique opportunity for Engineering at UCM. Our unique campus environment is an ideal location to cultivate Medical Imaging technology. This research area will apply tools in optics, physical chemistry, physics, computer sciences, electronics, nanotechnology and analytical chemistry for medical applications. The development of such technology enables many bioengineering research and clinical applications. Currently, there is no faculty with medical imaging background in BioE program. This proposed new hire will expand the research capacity and course diversity in our program. Medical Imaging research area represents an outstanding opportunity to involve faculty members in natural sciences, optical physics, bioengineering, materials science and engineering, mechanical and electrical engineering/computer sciences in a cross-disciplinary project.

Imaging for Stem Cell Tracking In Vivo (SoE) (2014-2015)- Recent developments in optical/imaging techniques (such as microPET, IR imaging, etc). Various stem cells hold promise for the treatment of human cardiovascular disease. Regardless of stem cell origin, future clinical trials will require that the location and number of such cells be tracked in vivo, over long periods of time. The problem of tracking small numbers of cells in the body is a difficult one, and an optimal solution does not yet exist. With the rapid increase of reported cases of stem cells being used to treat cardiovascular disease, it has become apparent that an urgent need exists to track stem cells in vivo during clinical trials. The problem of imaging small numbers of cells in the living subject is not limited to stem cell–based treatments in cardiology but has broad applicability in oncology, immunology, and transplantation. Ideally, imaging technology used for stem cell tracking would have single-cell sensitivity and would permit quantification of exact cell numbers at any anatomic location. Single-cell sensitivity is especially important in a new field such as that of stem cells because the pattern of migration of stem cells, even after local injection, is unknown, and there is a distinct possibility that single stem cells scattered diffusely throughout the body might be effective therapeutics for certain disease states. This proposed new hire will expand the research capacity and course diversity in our BIOE programs, as well as integrate with our QSB and BEST graduate programs and growing stem cell community.

BEST Interdisciplinary and Cross-School FTE Requests - none

BEST Space and Special Equipment Requests – none

Environmental Engineering

Overview: The Environmental Engineering program at UC Merced emphasizes a highly interdisciplinary approach to research, teaching, and service that combines theory with field studies, laboratory experiments and modeling. Core areas within the program include hydrology, climate, water quality, air pollution, and energy production. The Environmental Engineering program distinguishes itself among established programs through a focus on sustainability that forms a common thread through all curriculum, research, and service activities. A key feature in our strategy is that our program will be under 15 faculty for a number of years. We plan to incorporate sustainable engineering practices to expand our degree offerings and anticipate changing our name to Environmental and Sustainable Engineering in the next three years. The long term plan, in conjunction with the SOE is to develop an innovative civil engineering program. Although no civil engineers are in our strategic plan, in the next three years a task force will be formed to develop a plan for civil engineering that complements and expands environmental engineering. We are cognizant that to develop an innovative and robust program, we need to exploit our small size by integrating our activities with those of the rest of the University to make a truly interdisciplinary program.

Despite this programs recent formation, it has already developed an international reputation through a series of high-impact publications, recruitment and retention of outstanding faculty, a stellar record of peer-reviewed funding, and curriculum innovations. This document outlines a plan to further enhance the program's teaching, research, and service within the program theme of sustainability.

Environmental Engineering Mission Statement

The Environmental Engineering program is building the capacity for continued scientific discoveries and application of these findings for education and service. The program mission is includes the following:

- **Interdisciplinary Research**
  Core areas within the program include hydrology, climate, water quality, air pollution, and energy production. While the faculty and student research is based on core knowledge in these areas, this knowledge is applied to address large societal problems of sustainability through leadership of interdisciplinary teams. These interdisciplinary teams include researchers from across UC Merced and from outside universities, government agencies, and industry. In particular, the Environmental Engineering faculty will provide leadership for the cross-disciplinary initiatives on campus including the Sierra Nevada Research Institute (SNRI), The University of California Advanced Solar Technologies Institute (UC Solar) and the UC Merced Spatial Analysis and Research Center.

- **Innovative Teaching**
  The Environmental Engineering program prepares students for careers in academia, industry and government agencies concerned with managing water, energy, public health and the environment. The curriculum provides students with a quantitative understanding of the physical, chemical and biological principles that control air, water and habitat quality and sustainability on Earth, along with expertise in the design, development, implementation and assessment of engineering solutions to

environmental problems. Faculty in this program are thoughtfully engaging with new information technologies that will revolutionize how we communicate, who we teach, and what data we access.

- **Serving the San Joaquin Valley and Beyond**

The Environmental Engineering program leverages research and teaching to serve San Joaquin Valley and California. Faculty in the program mentor interdisciplinary student groups in engineering service learning projects that directly benefit the environmental sustainability goals of regional community organizations. The program is based on a culture that embraces the extraordinary diversity of our students and prepares these students to provide the future of engineering and scientific leadership in the San Joaquin Valley.

- **Common Theme of Sustainability**

Following the lead of the School of Engineering, the common theme of sustainability is integrated into all research, teaching, and service. Faculty and students in this program are continually asking how they can meet current needs without compromising our ability to meet future needs—whether they are studying larger societal questions related to water, air, or energy. This shared theme enhances connections with other researchers and teachers who are driven to address the grand challenge of sustainable development.

Goals and Major Outcomes

- Research Excellence
    - Publish high-impact studies in leading peer-reviewed journals
    - Earn research funding from competitive solicitations
    - Contribute to leadership of cross-disciplinary research initiatives including SNRI and UCSolar.

- Research: Societal Relevance and Community Engagement
    - Develop relationships with key stakeholders in ENVE faculty research, including State and Federal resource management agencies, private sector entities, and communities.
    - Foster application of science to critical societal challenges, such as climate change mitigation (sustainable energy and conservation), climate change adaptation (sustainable ecosystem services), public health (air quality monitoring, modeling and management), and ecological restoration (ecological engineering).

- Teaching
    - Achieve ABET accreditation for our Environmental Engineering program
    - Contribute to the broad education of undergraduates
    - Maintain a supportive culture that promotes diversity and recruits talented students into this program and inspires them to further their education.

- Service
    - Direct service to regional and global organizations through engineering service-learning projects.
    - Award degrees to students that leverage their Environmental Engineering education through careers and community service not only in thriving economic centers of the world but also in the San Joaquin Valley.

- Sustainability

- Earn a reputation for integrating the theme of sustainability throughout all research, teaching, and service activities of the program.
- Develop plans for broadening our degree program to encompass civil and sustainability engineering emphases.

Research

Focus Areas The environmental systems research in the Environmental Engineering program spans several areas. In all cases we seek to leverage expertise outside ENVE faculty. All EnvE faculty are in the Environmental Systems Graduate Group, as well as in other graduate groups and faculties at Merced and other UC campuses. Linking these research areas are the following:

Hydrology and Climate: Hydrology and Climate focuses on the sources, balance, use and impacts of water in both natural and engineered environments, including precipitation, mountain snowpack, river runoff, vegetation, water use and groundwater. Both the physical and chemical aspects of the water cycle are included. These studies span spatial and temporal scales to study interactions between climate, hydrology, ecosystems and disturbance regimes at seasonal to centennial scales, with applications for fire, fuels, carbon and air quality management, water resources management, climate adaptation and climate mitigation. The basis of the work is a strong observational program, involving both state-of-the art distributed wireless ground-based measurement systems, modeling across different spatial and temporal scales, and also satellite and other remotely sensed data. Mountain regions are experiencing unprecedented stresses, owing to shifts in temperature and precipitation patterns associated with climate change, as well as shifts in land use and land cover in response to growing populations. The process understanding and predictive ability for mountain hydrology, biogeochemistry and ecological and disturbance processes being developed by ENVE faculty will support planning and resource management decisions. To extend research in this area to include biotic influences on the hydrological cycle, the proposed positions in ecohydrolgy and ecological engineering would extend the expertise of the existing faculty, as well as increase the synergy with School of Natural Science faculty in ecology and biogeochemistry.

Supporting Faculty: Bales, Campbell, Conklin, Guo, Harmon, Westerling

Water quality:
The water quality area focuses on engineering solutions to water and waste issues, including measurement technology, water quality assessments, treatment systems and remediation of contaminated waters. Physical, chemical and biological aspects are included. Current projects span agricultural, riparian, groundwater-, and wetlands-related problems. A common theme is integrating measurements and mathematical models to better understand and manage pollutants in environmental systems. Another common theme is the application of distributed, embedded sensor network technology to assist us in understanding dynamic, spatially distributed problems in the environment. The proposed ecological engineering and environmental microbiology positions would extend the expertise of the existing faculty. Ecological engineering will increase the synergy between ENVE and Biological Engineering. Both positions will increase the synergy with School of Natural Science faculty in ecology and biogeochemistry.

Supporting faculty: Bales, Campbell, Conklin, Harmon

Air pollution and sustainable energy:

This focus area investigates solutions to air quality, climate and energy problems, both regionally and globally. The sources, fates, and effects of air pollutants, as well as the planning and design of solar and other renewable energy systems are tenets of a broad-reaching program that incorporates modeling, field observations, instrumentation, remote sensing and systems analysis. Solar energy research includes the development of medium-temperature solar thermal collectors and a project to initiate the development of a novel cost-effective concentrating photovoltaic system. Investigations of bioenergy resources such as ethanol and biomass electricity address the optimal pathways for mitigating the ecological impacts of growing biofuels and enhancing opportunities for net carbon sequestration. Of the three areas of expertise, this area is most closely aligned with Mechanical Engineering and seeks to leverage common research interests. Two of the proposed hires would extend the reach of this foci area, air pollution engineering and sustainable building design. Air pollution engineering (e.g. combustion engineering), is an area with synergy with mechanical engineering. A strategic hire in sustainable building design could lay the groundwork for developing a Civil Engineering program.

Supporting faculty: Campbell, Chen, Rogge, Westerling, Winston

Cross-disciplinary and cross-school linkages. Innovation is often produced at the intersection of various disciplines, which is why effective and talented interdisciplinary research teams are necessary to solve the world's most pressing issues. The Environmental Engineering faculty participate in the defining research and the leadership of SNRI, UC Solar Institute and the Spatial Analysis and Research Center. An Environmental Engineering faculty serves as the director of SNRI. Four of the faculty members in Environmental Engineering are joint appointments: two with SSHA and two with SNS, and their courses serve students in all three schools.

SNRI capitalizes on the vastness and diversity of the nearby Sierra Nevada and the adjacent Central Valley, where UC Merced is located. These regions, whose natural resources are so closely interwoven, provide opportunities to study forest, grassland, watershed and other systems. Researchers who study them are already making discoveries that will apply in similar situations all over the world.

Faculty research in the new Spatial Analysis and Research Center (SARC) includes applied spatial analysis techniques and novel methods to better understand environmental systems and manage natural resources. For example, applying geospatial techniques and satellite remote sensing data to analyze the Sierra Nevada water cycle and forecast snowmelt runoff, which informs decision making for resource management through California's Department of Water Resources and other regional and local stakeholders; using spatial analysis to develop a sustainable approach to biofuels production based on geospatial data; and developing novel geospatial methods for exploring billions of specimens of data held in natural history collections, to aid in conservation planning, reserve selection, environmental monitoring, and evaluating the potential impact of climate change on global biodiversity.

The UC Solar Institute, created in 2010 as part of the University of California's innovative Multi-campus Research Programs and Initiatives (MRPI) competition, the University of California Advanced Solar Technologies Institutes (UC Solar) is made up of faculty, researchers and students from five of the UC System's 10 campuses -- Merced, Berkeley, Santa Barbara, Davis and San Diego. The institute's faculty members include mechanical engineers, materials scientists, environmental engineers, physicists, biochemists and computer scientists, all working together to make solar energy systems more efficient and more affordable, while also educating tomorrow's solar energy leaders and entrepreneurs. Solar energy promises to be a key addition to the global energy supply, while at the same time its use reduces the use of fossil fuels and their impact on the environment. But for solar energy's promise to be fully realized, new advances in photovoltaic and thermal collection systems, solar irradiance forecasting, and grid integration technologies are necessary.

There is very strong synergy between the ES graduate program and the UC CITRIS (Center for Information Technology Research in the Interest of Society) and the new CITRIS initiative C-GRACE (CITRIS Global Research Alliance for Climate and Energy).

Teaching

All environmental engineering faculty contribute to delivering the undergraduate and environmental systems graduate curricula. In 2011 98 students declared Environmental Engineering as their major.

Undergraduate Programs

The fundamental teaching goal of Environmental Engineering is to provide our students with a broad curriculum that gives them experience with a wide range of subject areas and intellectual approaches, to prepare them to function creatively and independently, and lead in engineering practice and research within either traditional engineering and research environments, or in non-traditional multidisciplinary environments at the interface between engineering and a diversity of fields, including the physical, life, and health sciences, policy, business, and law. The study of environmental engineering provides students with a quantitative understanding of the physical, chemical and biological principles that control air, water and habitat quality and sustainability. Students majoring in this exciting field will be prepared to study and solve important problems in all areas of water, air and land resources management including observation and modeling of natural and engineered environmental systems, hydrology and water resources engineering, air resources monitoring and assessment, and sustainable energy systems.

UC Merced emphasizes a highly interdisciplinary approach to environmental engineering, combining a strong theoretical foundation with field studies, laboratory experiments and computations. Core courses within the major provide students with a firm foundation in the physical and life sciences and the ways that they apply to energy, hydrology, air and water quality issues. Emphasis areas allow students the flexibility to study in more depth by following tracks developed in consultation with their academic advisor(s). The main areas of emphasis for Environmental Engineering at UC Merced are hydrology, water quality and air pollution and sustainable energy.

Our goal in Environmental Engineering is to create an experience with an impact focused on (1) improving the connection between fundamental engineering curricula outlined above and modern engineering practice, and (2) maximizing the proportion of enrolled engineering students who complete engineering degrees.

Program Learning Objectives

Program Learning Objectives (PLOs) are broad statements that describe the career and professional accomplishments that the UCM Environmental Engineering (EnvE) program is preparing graduates to achieve. The UCM EnvE faculty, through consultation with its constituents (students, faculty, alumni, and External Advisory Board), has developed the following list of PLOs:

1. **Fundamental Knowledge**: EnvE graduates will have gained a strong foundation in basic mathematics, science, social science, humanities and arts, along with engineering principles, enabling active engagement as citizens in their communities.

2. **Critical Thinking**: EnvE graduates will be adept at applying critical thinking, problem solving, engineering principles and reasoning, the scientific method, and teamwork to solve environmental resource problems and to restore and sustain the global environment.
3. **Design Skills**: EnvE graduates will be prepared for advanced studies and research and/or employment advancement in a broad spectrum of industries and government agencies.
4. **Professional Skills**: EnvE graduates will communicate effectively in written, spoken, and visual formats with technical, professional, and broader communities.
5. **Ethics**: EnvE graduates will practice engineering according to the highest professional standards, demonstrating respect for social, ethical, cultural, environmental, economic, and regulatory concerns.
6. **Lifelong Learning**: EnvE graduates will be instilled with a desire to pursue life-long learning opportunities including continued education, professional licensure, challenging professional experiences and active participation in professional organizations.

The program includes service learning components designed to engage students in the solution of real-world problems in their community. The team projects resemble those found in actual engineering practice, with increasing responsibility as students progress through the program.

Engineers need to understand not only the technical but also the social and political contexts of their work. They must be able to communicate, and to plan, finance and market their products and ideas. Social sciences, business, humanities and arts courses are an important part of the curriculum. The result is a major that is hands-on and creative, engaging and adaptable.

Resources

Faculty

At a bare minimum, five FTEs will be needed to build capacity in air pollution engineering, ecological engineering, environmental microbiology, ecohydrology, and sustainable building design. These FTEs will complement the existing strengths of the program while helping to establish the sustainability program theme and provide a base for a degree in Civil Engineering. Expanding in these areas will leverage interdisciplinary synergies with other programs (e.g., Environmental Systems, Earth Systems Science, other engineering programs and the proposed management program). Research funding opportunities in these areas have been increasing over the last decade from a range of federal (NSF Environmental Sustainability; NSF Dynamics of Coupled Natural and Human Systems, NOAA climate program, USGS) and state (California Energy Commission, California Air Resources Board) sources, as well as various water resources agencies, and private foundations funding sources.

FTE positions for 2012-15 are as follows:

- **Air Pollution Modeling -** We recommend an assistant or associate professor position, preferably someone with both a management and technology focus in the area of air quality engineering. A background in mechanical engineering is desirable. This position could focus on engineering design of systems (e.g. combustion), technology for air pollution control, or modeling and impacts of air pollution. California's Central Valley offers an excellent natural laboratory for research to devise air pollution control systems. Organic and inorganic particulates, persistent organic pollutants, and precursor gases for ozone formation are produced during routine agricultural practices and weekday commutes. These pollutants are lofted into the atmosphere to interact with other chemicals or microbes and are eventually deposited in the respiratory systems of humans and animals, as well as on plant leaves. The resulting effects on human and ecosystem health are devastating. A significant air pollution-related research effort aimed at the understanding and mitigating the escalating air quality problems in the Central Valley, Sierra Nevada, and elsewhere has already been initiated in the Environmental Systems graduate group. This new position could also be helpful in understanding the effects of air quality on climate and of climate policy on air quality. This position is central to our developing strength in the air pollution area, and is an excellent complement to research by Rogge, Traina, Westerling, and Campbell in SoE and has synergy with ESS faculty (SNS) and is in the ES and SNRI strategic plans.

- **Ecological Engineering -** We recommend an assistant or associate level search for a faculty member who uses engineering principles to design sustainable systems that integrate human activities with the natural environment**,** with particular emphasis on the linkage between hydrologic and ecological systems. Possible areas of research emphasis include interactions among hydrologic, biogeochemical, physiological, and soil processes; hydrologic ecosystem services, integrating water quality, water cycling; spatial analysis and scaling. Use of remote sensing, field-based measurements, laboratory experiments and modeling are all of interest. The extensive and large-scale ecosystem restoration efforts planned in the Central Valley provide excellent opportunities for both natural laboratories, and research support through applications partnerships with local landowners and conservation entities. Similar efforts are being carried out across the Western U.S. This position would have collaborative opportunities and synergy with Campbell, Bales, Conklin, Harmon, Guo, Chin in SoE and has synergy with ESS faculty (SNS) and is in the ES and SNRI strategic plans.

- **Sustainable Building Design -** We recommend an assistant or associate professor position preferably someone who has extensive experience in sustainable, multi-stakeholder design methods and tools that incorporate lifecycle cost analysis, green architectural design, lighting and energy analysis. This position would have collaborative opportunities and synergy with Campbell, Winston in EnvE, ME and MSE and would be a building block in the development of a civil engineering program.

- **Environmental Biotechnology -** We recommend an assistant or associate professor position preferably someone who has extensive experience in the design optimal use of nature to produce renewable energy, for or nutrients in the remediation of urban and agricultural wastewater, design of advanced treatments or expertise in toxicology. The San Joaquin Valley is one of the fastest growing areas within the US and likewise harbors the most intensive agricultural industry in the Nation. Consequently, quality of land, water and air is a major issue, including the quality of water for households, crops growing and animal husbandry in large concentrated animal feeding operations. A great portion of the wastewater produced during agricultural activities is more or less released to the environment with little or no treatment. This position would have collaborative opportunities and synergy with Campbell, Bales, Conklin, Harmon, and Chin in SoE and has synergy with ESS faculty (SNS) and is in the ES and SNRI strategic plans.

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- **Environmental Microbiology** We recommend an assistant or associate professor position preferably someone with expertise that can range from cellular level to community level, e.g. cellular architecture, energetics, and growth; evolution and gene flow; population and community dynamics; water and soil microbiology; biogeochemical cycling; and microorganisms in biodeterioration and bioremediation. This position would have collaborative opportunities and synergy with Campbell, Conklin, Harmon, Chin in SoE and has synergy with ESS faculty (SNS) and is in the ES and SNRI strategic plans.

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- **Ecohydrology.** We recommend an assistant or associate level search for a faculty member who uses engineering approaches to quantify ecohydrologic processes on the catchment scale. As a discipline, ecohydrology addresses the bi-directional regulation of hydrologic and ecological processes, e.g., an integrated understanding of biological and hydrological processes at a catchment scale in order to create a scientific basis for sustainable management of freshwater resources. Possible focal areas include ecological measurements to protect and remediate catchment processes, improving ecosystem quality and services, environmental management. This position would have collaborative opportunities and synergy with Bales, Conklin, Harmon, Guo, Chin, Westerling in SoE and has synergy with ESS faculty (SNS) and is in the ES and SNRI strategic plans.

Core Facilities

Teaching: Our course offerings require a mixture of field and classroom facilities. For field facilities, we have leveraged facilities with outside entities and research facilities (e.g. field method classes routinely visit research sites to learn new techniques). We are slowly building facilities on campus, we are currently refurbishing a meteorological station on campus and upgrading it to provide real-time data to facilities and for use in courses. Availibilty of teaching and open access wet and computer laboratories are problematic. ENVE competes with Biology and Chemistry for wet laboratory space and ends up with non favorable times for laboratories (evening laboratories preclude water quality sampling). Due to the shortage of computer laboratories, students do not have access to computers with some licensed software outside of class time. Teaching facilities needed include access to a wet laboratory for 1.5 days per week, a machine shop for student projects, and increased access to open computer laboratories with course software and with state of the art computers. The school has been innovative in providing remote access to some programs, but this route is limited by software policies. The current situation ends up with professors serving as systems administrator, troubleshooting software installation/compilation across half a dozen operating system/hardware configurations on the students' own machines, obviously not an optimum situation.

Research: The main concerns are space for research groups and adequate/stable access to SOE server and professionally maintained clusters (see Table 1). Research facilities are tight with limited space for both wet and dry laboratories and graduate student offices. All faculty are experiencing shortage in the flexible space for grad students, technical staff and postdocs. While each faculty member needs core space for equipment and projects, the faculty, prefer to locate our technical staff and postdocs in flexible space that reflects ongoing projects. With the assumption of 200 sq. ft. per graduate student, and the assumption of 3 graduate students, staff and postdocs per faculty, current needs are about 4800 sq ft, this will increase with new hires. Currently SNRI supports an environmental analytical laboratory (EAL) and in 2012 the Spatial Analysis and Research Center (SARC) has been given a new facility in the new Social Science and Management Building. Many of the research projects are data intensive and data storage is a major issue. We need a stable engineering server, as migrating data libraries is time consuming. Faculty with larger computing needs need access to a professionally managed cluster for computing and storage (e.g. UCSD). Specific faculty may need access to a specific cluster (e.g. Campbell needs access NCAR cluster).

Table 1. Actual and Projected Space and Core EnvE Facility Needs

Faculty		Current Allocation	Projected (5 years)	Core Needs
Hydrology, Climate & Water quality	Bales	400 sq ft wet 400 sq ft dry	flexible space for grad students, technical staff and postdocs	EAL, SARC, field stations, SOE server
Energy & Climate	Campbell	~200 sq ft dry lab	~400 sq ft dry lab flexible space for grad students, technical staff and postdocs	Access to NCAR linux cluster
Air pollution, & Management	Chen (0.5)	~400 sq ft dry (SSM)	flexible space for grad students, technical staff and postdocs	Computation, data storage
Hydrology & Climate & Water quality	Conklin	800 sq ft wet lab	400 sq ft wet lab 400 sq ft dry lab flexible space for grad students, technical staff and postdocs	EAL, field Stations, machine shop, SOE server, SARC
Hydrology and Climate	Guo	600 sq ft dry lab 110 sq ft dark room	flexible space for grad students, technical staff and postdocs	Spatial lab, SOE server, cluster, and field stations.
Hydrology & Climate & Water quality	Harmon	400 sq ft wet lab 400 sq ft dry lab	Graduate student, postdoc and technical staff office space	EAL, Data storage, computational, SOE server and SARC
Air Pollution	Rogge	800 sq ft wet lab		EAL
Hydrology and Climate	Westerling	~400 sq ft dry (SSM)	flexible space for technical staff and postdocs	Computation, data storage, SARC
Energy	Winston	800+ sq ft dry lab (Castle)		
Air Pollution & Energy	Air Pollution Engineering		600 sq ft wet or dry lab; flexible space for grad students, technical staff and postdocs	Computation, data storage, cluster
Hydrology & Climate & Water Quality	Ecological Engineering		600 sq ft wet or dry, flexible space for grad students, technical staff and postdocs	Computation, data storage, cluster, other?
Sustainable Energy	Sustainable building design		600 sq ft dry lab, flexible space for grad students, technical staff and postdocs	Computation, data storage, cluster, other
Hydrology & Climate	Ecohydrology		600 sq ft dry lab flexible space for grad students, technical staff and postdocs	Computation, data storage, cluster, other
Water quality	Environmental Microbiology		800 sq ft wet lab flexible space for grad students, technical staff and postdocs	EAL, Computation, data storage, cluster, other

Materials Science and Engineering

Materials Science and Engineering (MSE) applies fundamental principles of physics and chemistry to designing materials with desired combinations of mechanical, optical, electrical, magnetic, electrochemical and other properties. Increasingly, innovative materials are being developed with the benefit of lessons that have been learned from nature. Examples include armor based on the structure of abalone shells and rats' teeth, optical materials that owe a debt to sea urchin spines and peacock feathers, high-performance ballistic fibers modeled on spider silk, self-cleaning surfaces copied from lotus leaves, and strong, reusable adhesives that emulate the behavior of gecko feet. Also encompassed in MSE are the methods by which particular atomic and molecular arrangements (nanostructures and microstructures) are achieved, the overall cost of the ingredients and processes used to produce particular materials, the effects of the environment on materials, the effects of materials and materials processing on the environment, and characterization of materials structure and properties. Because MSE embraces skills from physics, chemistry, mathematics and biology, it is especially appealing to anyone who enjoys interdisciplinary studies and who seeks to apply such knowledge to solving practical engineering problems. A strong sustainability theme is emerging in MSE as manufacturers juggle the competing demands of global industrialization, limited natural resources (raw materials), environmental legislation, whole life cycle design, and economic viability.

Susainability has been identified as a leading research priority for the School of Engineering and the UC Merced campus, while interdisciplinary research and education are hallmarks of UC Merced's culture. Strategic planning for MSE at UC Merced is focused on (1) building critical materials expertise into the sustainability research theme of the campus, and (2) supporting instructional programs *across SOE* and *the campus* at the undergraduate and graduate levels.

Sustainability Materials Research - Rising industrialization of developing countries in response to economic globalization since the late 1980s and population growth have contributed greatly to an unsustainable demand for energy and raw materials for manufacturing. China, in particular, is on track to become the top manufacturing nation in the world by 2020, and by some estimates has already become the world's second largest economy after the United States. This manufacturing capacity, initially spurred by export demand, is increasingly geared towards meeting the internal demands of a rising middle class in a nation in excess of 1.3 billion people. At the time of updating this document (March 2012), rare earth metals are headline news because of the interplay between supply, demand, internal politics in several countries (China, the USA, Australia and Malaysia), and concerns about environmental protection.

Rising materials demands are best illustrated with examples from the world's most populous, and arguably most economically vigorous nations. One of China's long-term plans is to develop a national electrical grid. However, the present value of all the copper resources in the word, estimated at $3 trillion, is not enough to build it, and known, recoverable reserves are projected to only last thirty years. China is also aggressively developing alternative energy sources (it has at present 25% of the world's installed solar energy base), and there is only a 10-year reserve of silver, a key metal for solar energy production. The combination of increasing demand and dwindling availability of natural resources due to increasing industrialization and long-term planning by developing countries such as China and India points to a rapidly accelerating scarcity of global energy and materials resources.

The role of materials science is clearly important in this global context. Sustainable materials to improve the efficiency of fossil, alternative, and nuclear energy production need to be developed; extraction and processing of minerals needs to become more efficient in terms of both metals recovery and energy usage; alternative materials that are less scarce need to be identified and developed as replacement materials for technological and other applications; and manufacturing processes need to be revised and optimized for sustainability. Future efforts need to include a close examination of the materials life cycle (materials production, manufacture, use and disposal) to identify more efficient processes. A paradigm shift is needed – from a focus on short-term design for the environment to long-term design for sustainability.

Among the plethora of possibilities for materials research in sustainability, some key areas that are synergistic with present efforts by other disciplines in SOE and across campus have been identified for development within MSE over the next several years. These areas include (1) sustainable manufacturing, and (2) sustainable building:

Sustainable Manufacturing - Sustainable Manufacturing seeks long-term alternative technologies, processes, materials, chemicals, and/or products so as to reduce pollution and waste, and create sustainable solutions. Its practice requires expertise in environmental regulations, recycling, life-cycle assessment, economic analysis, green chemistry and toxicology. Sustainable Manufacturing practice is rapidly becoming a necessity for companies engaged in manufacturing and several programs have recently nucleated around the country to meet industrial demand for training in this emerging field. Since the field is just developing, there is an opportunity at UC Merced to create a competitive research program in Sustainable Manufacturing that leverages the Sierra Nevada Research Institute and existing research and instructional programs in Environmental Systems, Biological Engineering and Small-Scale Technologies, Mechanical Engineering and Applied Mechanics, Computer Science and Quantitative Systems Biology, as well as the nascent School of Management.

To build and sustain (!) a program in sustainable manufacturing, expertise is needed in life cycle and cost-benefit analysis of materials and manufacturing processes, and in modeling of synthesis routes (often bio- or geo-inspired) to new metastable materials that reduce the use of energy and rare metals. These areas of research are computational in nature and have modest space and resource needs that can be met by shared faculty computer clusters or national computational facilities.

Sustainable Building - Sustainable building is an emerging area of interest for resource conservation, with a growing number of government agencies offering incentives for its practice. In addition, sustainable building is one of two research areas for the FY2010 Emerging Frontiers in Research and Innovation (EFRI) research program funded by the National Science Foundation. (The EFRI program was established by the Directorate for Engineering at NSF to focus on important emerging areas of research in a timely manner.) Green building materials are an important component of sustainable building practices that offer reduced construction costs, reduced maintenance and replacement costs over the life of the building, energy conservation, improved occupant health and productivity, and lower costs due to flexibility in design for specific occupants. The research emphases described above for sustainable manufacturing and energy materials can also contribute to a sustainable building focus in MSE. For example, a faculty with expertise in material lifecycle and cost-benefit analysis can contribute analysis of the resource efficiency of proposed green materials, while expertise in energy materials can contribute to the identification and development of cost-effective methods of conserving or harvesting energy in buildings. In addition, we would like to build expertise in structural materials with MSE to further the development of new green building materials that reduce the use of nonrenewable resources and environmental degradation. This position can be computational in nature and have modest space and resource needs that can be met by shared faculty computer clusters or national computational facilities.

MSE at UC Merced already has an identifiable research thrust in sustainability, evident in the current faculty's research activities in energy-related materials and non-traditional materials. Jennifer Lu studies the synthesis of carbon nanotubes and other nanostructures and nanomaterial-based composites for photovoltaic, battery, and energy-scavenging applications. Lilian Davila's modeling studies of materials structure–property relationships are being applied to nanosensor design, sequestration of nuclear waste, nuclear fusion, and hydrogen and energy storage. Vincent Tung's research on carbon-based soft electronics explores materials phenomena of fundamental interest to renewable energy. Valerie Leppert is applying her specialty in materials characterization (electron microscopy) to study the impact of nanomaterials (production, use and degradation) on the environment. Christopher Viney's research on bioinspired materials provides lessons on efficient, sustainable use of matter and energy through environmental benign processing routes. The proposed additions to the MSE faculty would bring focus and strength to this enterprise.

MSE Support of Instructional Programs

The MSE faculty have designed an efficient curriculum with five required and (currently) five elective MSE courses for undergraduate students that allows the program to still make a significant contribution to several instructional programs in engineering and across campus.

In addition to serving their major and the BEST graduate program, the MSE faculty are making notable contributions to engineering as a whole and to general education. All courses offered by MSE are open to students from other majors. In addition, MSE faculty currently teach ENGR45 (Introduction to Materials; an Engineering Fundamentals course) and ENGR170/270 (a specialist electron microscopy course), as well as mentoring the two longest-running Engineering Service Learning projects. In addition, MSE faculty contribute to General Education via CORE1 and undergraduate research opportunities.

The addition of elective courses in sustainability, with a view to developing an emphasis in sustainable materials, will underline UC Merced's commitment to – and enhance UC Merced's already strong reputation as a forward-looking leader in – the scholarship of sustainability.

Resource Requirements

Academic resource requests for MSE are based on the discipline's contribution to sustainability research themes at UC Merced, its contribution to instructional programs across SOE and general education, and its undergraduate and graduate teaching needs.

MSE Academic Resources (FTE) requests

<u>Priority</u>: **MSE-6 (Computational): Sustainable Materials -** An FTE in computational materials at the Junior/Senior level, centered on modeling of metastable materials processing is requested as a priority in Year 2. This hire would contribute to ongoing efforts in sustainability through the design of replacement materials for manufacturing/building sustainability as well as new materials for energy. Modeling assists the development of new materials through

- identifying alternative formulations for materials to reduce dependence on particular sources and/or reduce the output of particular pollutants;
- identifying efficacious metastable pathways for materials synthesis and processing that may be inspired by nature;
- identifying new processing techniques that can be used to improve the recyclability of materials (pressure fabrication of hard plastics vs. thermosetting that allows recycling of hard plastics, for example).

There are also collaborative opportunities with cognitive science that explore the use of materials visualization for materials teaching and learning. Since this is a computational position, no experimental laboratory space is needed (only space to house computers and researchers). Start-up costs are minimal, with shared computer clusters or national computational facilities available.

In addition, MSE proposes the following cross-school opportunity hires:

Sustainable Manufacturing Management - We are proposing an opportunity hire in Engineering to contribute to development of the School of Management, specifically to allow the establishment of a Sustainable Manufacturing Management program that can leverage existing courses across multiple instructional programs. This leadership position requires a tenured faculty member at the full or associate professor level. Appropriate disciplinary backgrounds for this position include industrial engineering, engineering economics, management and/or economics, environmental engineering, or materials engineering. A research emphasis on lifecycle and/or cost-benefit analysis would complement existing faculty expertise in the Schools of Engineering and Natural Sciences. The ideal candidate would have a proven track record in connecting engineering economic analysis to research in environmental systems, toxicology, or materials engineering, as well as the social science and policy aspects of sustainable manufacturing. The space and start-up needs for this position are modest, as it is theoretical in nature.

Technology Management - We are proposing an opportunity hire in Engineering to contribute to development of the School of Management, specifically to allow establishment of a Technology Management program that can leverage existing courses across multiple instructional programs in Engineering and Natural Sciences.

Table 1. Actual and Projected Space and Core MSE Facility Needs[6]

Faculty		Current Actual[7]	Projected ***Additional*** Needs (3 years)	Core Needs
Computational Materials Science	Davila	1 Bay (300 sq. ft)	Minimum 1 ***additional*** Bay (+300 sq. ft or more) for additional students and equipment.	Experimental space to accommodate a Hybrid Lab Model: experiments and simulations.
Electon Microscopy; Nanomaterials	Leppert	1 Bay (300 sq. ft) 235F (210 sq. ft wet)	Minimum 1 ***additional*** Bay (+300 sq. ft or more) for additional students and equipment.	
Functional Nanomaterials; Materials Synthesis	Lu	2 Bays (600 sq. ft) 235A (92 sq. ft wet) 235B (201 sq. ft wet) 235D (116 sq. ft wet) 235M (283 sq. ft dry)	Minimum 1 ***additional*** Bay for additional students and optical set-up. 2 ***additional*** fume hoods.	Fume hoods
Energy Materials	Tung	1 Bay (300 sq. ft) 235E (199 sq. ft wet)	Minimum 1 ***additional*** Bay (+300 sq. ft or more) for additional students and equipment. 2 ***additional*** fume hoods.	Fume hoods
Biomimetic, Polymeric and Liquid Crystalline Materials	Viney	1 Bay (300 sq. ft; some of this shared)	Minimum 1 ***additional*** Bay (+300 sq. ft.) for additional students and equipment. 2 fume hoods	Fume hoods
	(Shared)	235C (116 sq. ft dry) 235N (283 sq. ft dry)		
MSE 6	tbd		300 sq. ft + office	Computational

[6] Square footage provided by G. Gavilan, from Facilities Information System (UC Merced's Capital Planning facilities data and inventory).

[7] 235M and 235 N are the two hallway areas.

Mechanical Engineering

1. Overview

The Mechanical Engineering faculty at MERCED are affiliated primarily with the **Mechanical Engineering and Applied Mathematics** (**MEAM**), but several ME faculty are also affiliated with the BEST, and ES graduate programs. The ME faculty are dedicated to the education of a new generation of mechanics researchers, applied mathematicians and/or researchers of ME-related areas who aim to master the fundamentals of the mechanical sciences (which include disciplines such as continuum mechanics, rheology, fluid mechanics, heat and mass transfer, energy conversion, etc.) while being exposed to the forefront of research techniques, methodologies and equipment to solve problems that are relevant to modern society (green energy, mechanical modeling and synthesis, robotics and mechatronics, control systems, etc.).

2. Mission Statement

The mission of the MEAM program at UC Merced is to provide a modern, comprehensive, and interdisciplinary educational experience to its students with the objective of preparing them for successful careers in the current and dynamically changing professional environment. To achieve this mission, the MEAM program strives to accomplish the following educational objectives:

Program Educational Objectives

- To provide a solid background on the pertinent mathematical, physical, chemical and engineering concepts that make up the foundations of the broad disciplines of mechanical engineering and applied mechanics, as well as on their closely associated fields;
- To provide our students with the knowledge to correctly apply natural laws to the creative formulation and solution of engineering problems through the use of analytical, computational and experimental techniques;
- To expand the reach of research in mechanical engineering and applied mechanics to non-traditional areas by continually seeking to incorporate new methodologies and research findings to our graduate curriculum.

3. Research

Mechanical Engineering and Applied Mechanics represent four distinctive but overlapping research areas that together form some of the most fundamental pillars of the academic enterprise. While the various disciplines that compose the field of Applied Mechanics are associated with rigorous and rapidly developing branches of human thought, Mechanical Engineering is currently undergoing a fundamental transformation at several distinct levels. At the design level, computer aided engineering and fast prototyping automated tools are revolutionizing the way new products are conceptualized, evaluated and deployed into the market. At a more fundamental level, computational methods that are based on judicious use of advanced concepts in Applied Mechanics (including stochastic evolutionary methods, uncertainty analysis, artificial cognition, etc.) have expanded the portfolio of research methodologies much beyond the usual designer-based experience. Today, Mechanical Engineering is evolving into a discipline where more emphasis is placed on teaching a machine how to design, other than using the machine to optimize a pre-selected design. In other words, instead of using the engineering methodology to optimize a pre-existing concept, MEAM research is transitioning to a new paradigm where only the goals and constraints of the object are known to the designer, and a stochastic algorithm uses a variety of advanced computational methods to explore the complete space of solutions that satisfy the goals and constraints of the problem at hand.

The MEAM group at UC Merced emphasizes this new approach to Mechanical Engineering, and therefore is unique among all UC campuses in placing a much higher emphasis on advanced computational methods. Formed in August of 2007, the MEAM group is composed of faculty members from various disciplines, including Mechanical Engineering, Electrical Engineering, Physics, Applied Mathematics, Materials Science, and Computer Science and Engineering.

Research Themes of MEAM Program

As mentioned above, there are many exciting research opportunities within the context of the MEAM program, and we have prioritized research areas that would better complement and add value to the overall research and educational mission of UC Merced. The chosen research themes also add a unique flavor to our program not only within the UC system, but also in comparison to other programs in the nation. The MEAM program will initially focus on four major themes – (I) Energy Systems, (II) Biologically Inspired Technology, (III) Fluids and Reacting Flow, and (IV) Mechanical Design and Controls – which are described below.

(I) Energy Systems

Mechanical engineering is a core discipline for the development of energy conversion and storage technologies, and the MEAM program at UC Merced is well poised to take the lead on the renewable energy initiative in our campus. There is very strong synergy between the MEAM graduate program and UC Solar, UC CITRIS (Center for Information Technology Research in the Interest of Society) and the new CITRIS initiative C-GRACE (CITRIS Global Research Alliance for Climate and Energy). Within the Energy Systems theme, the main areas of activities of the MEAM program include: solar concentrators, solar availability mapping, renewable fuel conversion, fuel cell technology, concentrator controls, direct solar conversion, and solar power applications to environmental health monitoring.

In the next five years, we would like to build a strong focus on energy research, and shall explore the research topics including solar energy, wind energy, building efficiency, and energy storage technologies.

(II) Biologically Inspired Technologies

We foresee bio-based research as a source of inspiration for futuristic designs of various mechanical systems. There is important synergy with experimental methods in bio-controls, mechatronics, multi-scale material properties, and complex fluids that will enable the maturation of this area into a new paradigm of engineering design. A strong computational component on novel genotype optimization methods will allow us to explore bio-inspired solutions beyond the traditional bio-mimetic approach. It is the concurrent and parallel experimental development of advanced materials and biologically inspired designs that will enable the development of a full spectrum of engineering solutions for complex systems. An important component of the MEAM strategic plan is to build critical mass in this research theme.

(III) Fluid Mechanics and Thermal Sciences

Laminar and turbulent fluid flow plays an important role in many processes in nature and technology, including the ozone in the atmosphere, environmental effects of pollutants, cooling of industrial equipment, power plants, etc. Reacting flows, mostly turbulent, are encountered in most modern engineering applications, such as gas turbine engines, automobile engines, and other combustions systems, as well as in many aerospace applications, and research is required to achieve efficient and clean use of energy. This research theme includes stochastic modeling of complex flow systems, computational algorithm development, advanced flow measurements and control technologies, and novel experimental studies. This research theme also provides important theoretical and experimental support to the Energy Systems research area, and is naturally linked to the research in the area of Environmental Engineering.

(IV) Mechanical Design and Controls

Design of mechanical components is a cornerstone of both traditional Mechanical Engineering and its application to cutting-edge technologies. This research thrust encompasses a wide range of disciplines including manufacturing, measurements/analyses, optimization and computing capabilities not restricted to creative design itself, coupled with our increased understanding of mechanical system behavior. The Mechanical Design and Controls area will be a key part of the previously mentioned transition of Mechanical Engineering to a new paradigm where only the goals and constraints of the object are known to the designer, and a stochastic algorithm uses a variety of advanced computational methods to explore the complete space of solutions that satisfy the goals and constraints of the problem at hand.

The four research themes above reflect a sensible compromise between depth, breadth, impact and quality of MEAM research. Equally relevant is our effort to combine the needs of the very popular undergraduate program in Mechanical Engineering with the development of a strong research program in MEAM.

4. ME Undergraduate Program

The mechanical engineering (ME) undergraduate major was launched during Fall 2006 accepting only freshman students. The plan was to start accepting transfer students only in the Fall 2008. However, a large number of current upper division students at UC Merced have approached ME faculty or the engineering student counselors to explore the possibility of transferring to the ME major before they complete their degree. By now, ME has become the most popular engineering major at UC Merced. In Fall 2009, we had 176 ME students, the largest group among all the majors in Engineering, with only five faculty. In 2011 it increased to 302 students for six faculty members. Thus, ME has currently the second largest student-to-faculty ratio in the SoE.

To evolve into a top ME program, it is absolutely necessary to develop a strong and comprehensive foundation in key areas, with a sufficient number of faculty to build a modern program with state-of-the-art research infrastructure. In addition, because ME is a key component of any modern engineering academic program in serving key and foundational needs for many engineering sub-disciplines. Delaying the hiring of ME faculty will dramatically constrain the growth of our engineering program and could significantly impair the image and reputation of the ME program and the School of Engineering as a whole.

Currently, ME provides service to other majors by teaching a number of engineering fundamentals courses that include: ENGR 57 (Dynamics), ENGR 65 (Circuit Theory), ENGR 151 (Strength of Materials), ENGR 130 (Thermodynamics), ENGR 135 (Heat Transfer), and others. This situation increases dramatically the teaching load of ME faculty.

From the outset, there was a concerted effort to provide a seamless experience to SOE undergraduate students interested in pursuing post-graduate education in the MEAM program. The MEAM program offers research opportunities for students interested in projects at the interface between Complex Analysis, Mechanics, Manufacturing, Bio-Inspired Engineering, Applied Computational Sciences, Mechatronics, Advanced Materials, Energy Conversion, and Controls. Due to the interdisciplinary nature of the topics covered in MEAM courses, a number of these courses serve graduate students from many different disciplines. This also increases the teaching load of ME/MEAM faculty. For instance, in the past the following courses were populated by graduate students from other programs: ME 135/ES 235 (Heat Transfer), MEAM 201 (Advanced Dynamics), ME 210 (Linear Controls), and MEAM 251/ES 237 Viscous Flows.

There are currently six FTE positions filled in mechanical engineering (listed here in order of hiring): Professor Diaz, Professor Sun, Professor Modest, Professor Ma, Professor Martini, and Professor Lee.

5. Resources Requirement

Faculty–We need about 20 faculty to establish a ME program, which is reputable and competitive in the nation, and can be ABET accredited. For the next five years, a total of ten desired positions have been identified and described below in descending level of priority for both the ME and the MEAM programs. The research themes corresponding these positions are also identified.

1) Stochastic Modeling (I, II, III, IV)
2) Complex Flow (I, III)
3) Multi-scale Solid Mechanics (I, IV)
4) Bio-Controls (II, IV)
5) Energy Transport and Conversion (I, III)
6) Buildings Energy Efficiency (I, IV)
7) Bio-Inspired Mechanics (II)
8) Complex Systems (I, II, III, IV)
9) Thermofluids (I, III)
10) Nonlinear Dynamics and Control (I, II, IV)

Instructors and other support personnel - In addition, four instructors will be needed to cover the engineering fundamentals and capstone design.

For AY 2011-2014, the program is requesting ***three lecturers***. One will concentrate on the engineering fundamentals (ENGR) courses that serve all programs in the SOE, and the other on ME electives that may serve BIOE, ES, ME, MSE and CSE students. The final lecturer will help faculty to develop and deliver the capstone and other design-related courses. Lastly, a technician will support the teaching and research labs with electronics and power electronics skills.

Space - There is a minimum number of specialized faculty members required to deliver a comprehensive program such as Mechanical Engineering in parallel to a successful graduate program in MEAM. Although we are falling short of the projected need for FTEs, an even more pressing problem is space allocation for both instructional and research use. The ME/MEAM faculty believe that the instructional laboratory allocation to ME-lead classes is insufficient for achieving success in the accreditation process with ABET.

Core Facilities -Both the MEAM research program and the ME instructional program need adequate lab space and machine shop support to exist. The current machine shop is not supported at a level that will allow Capstone Design and MEAM research programs. This limitation will severely impact the ability of the ME program to be ABET accredited in the coming years. All ME faculty members, in collaboration with the SOE staff, have been actively involved in extracting the most out of the limited instructional lab space available to deliver the ME classes. However, even considering the best use of the instructional labs (which include rotating schedules, sharing of the labs by several different disciplines, and modular educational benches that are put aside after use) it is very clear that the currently available space will not withstand ABET scrutiny. The same is true with the machine shop support.

The MEAM needs in terms of space include extra 5,000sf laboratory space beyond what is available now for ME faculty, of which about 2,000sf need to be “damp” lab space. Given our emphasis on computational methods, this need is rather modest in comparison to other graduate programs, but it is critical for us in order to attract the few experimentalists needed for reaching critical mass in both energy systems and bio-inspired technologies.