Academic Year 2008-09
Strategic Plan

School of Engineering
University of California, Merced

January, 2008

Contents

1 INTRODUCTION: ACADEMIC VISION 1

1.1 FOCUSING ON RESEARCH SYNERGIES 2
1.2 SCOPE OF THIS DOCUMENT 2

2 ACADEMIC PROGRAMS DEVELOPMENT 5

2.1 ANTICIPATED STUDENT GROWTH AT UC MERCED 5
2.2 PROGNOSIS FOR GROWTH OF ENGINEERING FACULTY RATIOS 7
2.2.1 The desired fraction of Engineering students at UC Merced 7
2.2.2 Targeted student/faculty ratio within the School of Engineering 8
2.2.3 Implications for faculty Engineering FTE requests 9
2.2.4 Workload Considerations 11
2.2.5 Summary of current and authorized faculty FTEs (need update) 11
2.2.6 Faculty Diversity 12
2.3 5-YEAR PLAN FOR EXPANSION OF ACADEMIC PROGRAMS 14
2.3.1 Electrical Engineering 15
2.3.2 Chemical Engineering 18
2.3.3 Engineering Economics and Management 19
2.3.4 Development of a Management Program and School 19
2.3.4.1 Natural Resource Management 19
2.3.4.2 Entrepreneurship 20
2.3.4.3 Management of Technology 21
2.3.4.4 Energy, Climate, and Sustainability 22
2.3.4.5 Biotechnology Management 23
2.3.4.6 Center for Entrepreneurship 23
2.4 REQUEST FOR SCHOOL OF ENGINEERING FACULTY POSITIONS FOR 2008-09 24
2.4.1 Bioengineering: Tissue Engineering 25
2.4.2 Bioengineering: Physiological Modeling 25
2.4.3 Bioengineering: Single Cell Quantitative Measurements 26
2.4.4 Computer Science Engineering: Instructor with security of employment. 26
2.4.5 Computer Science Engineering: Senior position complementary to existing CSE faculty with research emphasis in CS. 27
2.4.6 Computer Science Engineering: Senior position complementary to existing CSE faculty with research emphasis in EE. 27
2.4.7 Computer Science Engineering: Senior position complementary to existing CSE faculty with research emphasis in EECS. 27
2.4.8 Computer Science Engineering: Media Arts and Technology (MAT) (Cross-school) 28
2.4.9 Environmental Engineering: Junior or Senior Hire Environmental Microbiology. 28
2.4.10 Environmental Engineering: Junior or Senior Hire in Ecohydrology and Ecological Engineering. 28
2.4.11 Materials Science Engineering: MSE-6: Complex Materials 30
2.4.12 Mechanical Engineering: ME-6: Bio-Control 32
2.4.13 Mechanical Engineering: ME-7: Computational Engineering 33
2.4.14 Cross-School Hire 36

3 STRATEGIC PLANNING FRAMEWORK 37

3.1 REVISITING THE STRATEGIC FACULTY HIRING FRAMEWORK 37
3.1.1 Energy and Materials Technologies 37
3.1.2 Biological Engineering 39
3.1.3 Nanoscale Systems 39
3.1.4 Environmental Science and Engineering 39
3.1.5 Computer Science and Engineering 39
3.1.6 Modeling Sciences 41
3.2 STRATEGIC FACULTY HIRING 42

4 SPACE PLANNING AND MANAGEMENT 43

4.1 SPACE CHALLENGES AT UC MERCED 43
4.2 SPACE ALLOCATION, UTILIZATION MONITORING, AND REALLOCATION 43
4.2.1 Initial campus space allotment 43
4.2.2 Initial engineering research space allocation 44
4.2.3 Core research facilities 46
4.2.4 Teaching laboratory space allotment 46
4.2.5 Space utilization monitoring and reallocation planning 47

1 Introduction: Academic Vision

The goal of the School of Engineering at University of California, Merced is to develop a program that fosters fundamental research advances, the education of exceptional students, and the continued support of alumni who will assume leadership positions at all levels of engineering professions. Our highest priority is to create an environment for research and education that is aimed at changing the world around us. This document presents a strategic plan for faculty hiring for the School and discusses how this will assist us in achieving our full potential as a leader in engineering research, education, and professional service.

A major constraint in achieving our goal is the necessarily limited size of our faculty over the next few years. But it is imperative that we grow steadily and deliberately—particularly in our signature areas—and that our momentum in student recruiting, infrastructure development (both teaching and research support), and space and facilities not be hindered. In order to continue to compete with other universities, for which a sufficiently large Engineering faculty is essential, the School must exploit its small size by integrating our activities with those of the rest of the University. Anticipating that over the next decade, we will grow in size only to approximately 100 faculty, in part through joint appointments with other Schools in areas of mutual interest, a clear hiring strategy that is aggressive yet realistic is particularly important. This strategy is timely and essential, taking advantage of the fact that research in the sciences is rapidly becoming more technology based, allowing UCM to take the lead in applying engineering methodologies to new scientific frontiers.

The central theme of our strategic plan is our choice of selected research areas for investment and growth. We plan to emphasize six areas of research that we believe are critical for UCM's continued success: (1) Energy and Materials Technologies, (2) Biological Engineering, (3) Nanoscale Systems, (4) Environmental Science and Engineering, (5) Computational Science and Engineering, and (6) Modeling Sciences. These areas represent research activities that stretch across the School and the campus, and have the potential for strong and nourishing linkages across the University system, thus further leveraging our multi-disciplinary emphasis. At the same time, we realize the need to maintain strength in core disciplines and to balance these thrusts with disciplinary needs. This is specifically supported through the use of a hiring matrix that promotes this balance, and recognizes explicitly our responsibility to build a strong program for education of undergraduates, and support of the engineering professions. The School is also committed to combine teaching efforts, research activities, and public/community service through creative partnerships at the local and state levels.

Our graduate and undergraduate education will continue to provide a science-based, research-oriented curriculum that educates the next generation of innovators and leaders in engineering and enabling technologies. The School is committed to attracting and educating students from populations that have traditionally been underrepresented within the engineering profession, and to broadening their participation at all levels. To the extent that the development and timely evolution of new facilities can be coupled with *a long-term space plan* for the School, we will be able to provide an exceptional environment for research and education. The plan presented here represents a view of our School that will guide our detailed decisions over the next several years.

1.1 Focusing on Research Synergies

In response to the comments provided by CAPRA to the AY 05-06 School of Engineering Strategic plan, the faculty established a planning framework (matrix) that would guide future faculty FTE requests consistent with strategic and emerging research opportunities. This framework has as its central focus, an articulation of the research synergies not only between academic programs within the School of Engineering, but also between and among our sister Schools, graduate groups, and research institutes. It was offered as a framework that could be used to enhance communication among these entities, and was put forth as a means of providing continuity to the overall university strategic planning process.

The updated strategic planning matrix from AY 07-08 is reproduced herein as Table 1. The objective behind the use of this framework was to relate the faculty hiring plan of the School of Engineering for both current and future (requested) positions more explicitly to (1) our strategic intra-School research areas, and (2) strategic cross-School research areas set forth as listed in all three Schools original strategic plans. Because of the importance of Engineering's goal of developing (ABET) accreditable degrees, the academic undergraduate majors are also included as an important dimension of this framework.

The rows of the matrix are the strategic areas that have guided the School of Engineering's strategic planning process. The first areas listed are those that were agreed upon by the Schools as areas of particular interest for possible joint hires last planning cycle, and that motivated the allocation from the Provost of the cross-school positions currently being recruited. The columns of the matrix list research focus areas within Engineering—grouped by what would be departments at most universities—*majors*, at UC Merced, and areas of particular interest for recruiting Engineering faculty. The remaining areas listed—those below the double line—are those that were considered more likely to be of interest between or among engineering subdisciplines than between Engineering and other Schools.

The entries in this matrix described both our current faculty hiring profile at that time, and requested FTEs. The green cells denoted those faculty already hired, or anticipated to be hired to fill our inaugural 20 positions, and reflected their relationship with their specialty within Engineering, their principle teaching responsibilities, and their major multidisciplinary synergies with other academic entities (Schools, grad groups, institutes, etc.).

1.2 Scope of this Document

Before being able to propose confidently a specific hiring plan for the coming year and future years, it is important to establish a foundation for requesting a feasible number of faculty FTEs. A foundation that ties our annual faculty FTE request to student numbers and the evolution of our programs is presented in Section 2 with an overall review of projected student growth, followed by a discussion of targets for the fraction of UC Merced students who are engineering students, leading to targets for engineering student/faculty ratio. Section 2 concludes with a profile of our revised 5-year hiring plan, and our request for FTE positions to be hired during the next academic year.

Based on this FTE request—number of faculty positions that can reasonably be expected—our strategic cross-disciplinary hiring strategy is updated—as Table 10—showing the anticipated impact that allocation would have on the strategic research opportunities for the School of Engineering and UC Merced. The document concludes with a discussion of our space challenges. Further details of resource needs associated with the hiring of new faculty

are given in the Resource Plan submitted by the Dean of the SOE to the Provost for AY 2008-2009 (Appendix I of this document).

Table 1 – Framework proposed last year—AY 2006-07—by Engineering for strategic cross-Schools hiring plan.

Strategic Research Priorities within the School of Engineering

Strategic Faculty Hiring Planning Matrix--This matrix is intended as a framework for displaying the structure of faculty hiring within the School of Enigneering at UC Merced. The left column presents the strategic research priorities within Engineerring. Each area is further categorized by potential cross-School priority areas. The columns to the right reflect research emphasis areas grouped by disciplinary categories, also reflecting our current and future undergraduate majors. Entries in the table correspond to current, pending, and desired future faculty hires.

Current and Planned Undergraduate Majors witin the School of Engineering

Strategic Cross-School Research Opportunities	ENVE					CSE				BIOE					ME					MSE					EE						
	Hydrology	Microbiology	Water Quality	Air Pollution	Environmental Sustainability	Energy water & resource management	Networking	Data Base Mining/Informatics	Robotics/Autonomous Agents/AI	Graphics/Multimedia	Architecture/Systems	Bioelectronics	Biomaterials Engineering	Cellular Bioengineering	Tissue Bioengineering	Bioprocess Eng	Energy and Environment	Computational Mechanics	Complex and Intelligent Systems	Multiscale Physics and Modeling	Bioengineering	Nanomaterials	Composite materials	Materials Synthesis	Materials characterization	Environmental Aspects Materials	Materials Processing	Microelectronics and Nano Technology	Communication Networks	Bioelectronics	Optics and Photonics	MicroElectroMechanical Systems	Signal Processing	Circuits	Linear/Nonlinear Systems, Control
Energy and Materials Technologies: Energy; including optics, material sciences					☒																	☒									■				
Energy and Materials Technologies: Mechanical and electromechanical systems														■		☒			■					☒							☒				
Biological Engineering: Human biology, health and enviroment, including management and policy														☒																					
Biological Engineering: Regenerative medicine													■		☒																				
Nanoscale Systems: Nanotechnology												☒													☒		■								
Nanoscale Systems: Human dimesions of engineering and science																																			
Environmental Science and Engineering: Atmospheric & climate sciences, air resources			☒	☒		■																													
Environmental Science and Engineering: Energy, Water & Environmental sustainability, including policy	☒		☒		■	☒																													
Environmental Science and Engineering: Geography and spatial analysis and global change						☒	☒	☒			■																								
Computational Science and Engineering: Cognitive and computational sciences								☒	■	☒																									
Computational Science and Engineering: Media arts and Technology																																			
Computational Science and Engineering: Cyberinfrastructure and system							☒		☒		■																								
Modeling Sciences: Management and decision sciences					■	☒																													
Modeling Sciences: Mathematical sciences, applied mathematics, and applied statistics								☒						■			☒	■	☒		☒	■													
	8						9					6.5					6					5					1.5								

- Engineering faculty (first 20)
- ☒ Engineering faculty already hired
- Joint (cross-school) faculty hires or joint hires requested
- Joint (cross-engineering) faculty hires or joint hires requested
- Current faculty searches
- To be requested; need to be distributed into the matrix

This framework was used by the School of Engineering to articulate the relationship between cross-School strategic research faculty hiring requests and the majors within the School. It was suggested that an extended version of this framework be used in support of a comprehensive UCM hiring map with strategic cross school areas included as the rows of the table, with more School-specific research areas grouped by respective School undergraduate majors be used in considering future faculty hires, particularly cross-School hires.

The School of Engineering has refined this framework, and updated the matrix in presenting our AY 2008-09 hiring request, as presented in Table 10 of Section 3 of this Strategic Plan.

2 Academic Programs Development

The key resource for the strengthening and growth of academic programs within the School of Engineering is the faculty. Provided that we can hire a sufficient number of faculty having sufficient experience in building strong scholarly programs, we will grow at a reasonable rate into a leading engineering program. This is particularly challenging because of the extreme burden placed on faculty time required for program building—infrastructure, curriculum, programs to promote student success, etc.—all while maintaining the requisite high level of academic stature essential for a UC campus. The challenge is made even more daunting by the specter of inadequate future space for programs development, difficulty in attracting top graduate students, and continued substantial responsibilities for involvement in shared governance spread among relatively few—in contrast to established campuses—individuals. It is therefore unfortunate that future faculty FTE allocations to the Schools is based primarily on numbers of potential undergraduates who, as early high school seniors, are required to make a selection about the School and major through which they intend to matriculate.

This is especially challenging for Engineering because more than other professional disciplines or academic areas, the fields of engineering or the nature of what engineers do is not well known or understood by the general public and certainly not by typical high school students when they are presented with the need to commit to a Major course of study on an application form. The failure of UC Merced to succeed in our early goal of having a common freshman year across Schools preempted our vision of creating a first-year learning experience designed to help students make better decisions about their field of study. While this may not have increased the numbers of students choosing Engineering as a career choice, it would very likely have helped improve the retention rates among those who do.

Nonetheless, in order to prepare a realistic plan for faculty hiring in Engineering, we must begin with the reality of using potential undergraduate student Majors designation as a basis for potential faculty FTE allocations to the School. Section 2.1 of this document presents our perspective on the anticipated growth of student numbers and the resulting implications for FTE allocation to Engineering over our 5-year planning period and beyond. This provides the foundation for a more detailed discussion about how the anticipated allocation of FTEs to Engineering would be strategically allocated among disciplinary areas, and supports a subsequent discussion about the potential for hiring faculty for purposes of exploiting potential synergies across the Schools and among our graduate groups and institutes.

2.1 Anticipated Student Growth at UC Merced

The growth targets for UC Merced remain unchanged from those set forth in the original planning projections of the University as contained in the UC enrollment plan for the system. Column 2 in Table 2 presents these growth targets for UC Merced modified to reflect the 2005-06 actual admissions[i], and extending through 2011-12. Starting from a first-year enrollment of 875 students, it has been projected that UC Merced will enroll sufficient students each academic year that will result in a net increase of 600 student FTEs each year for the next 5 years resulting in a total student population in the fall 2010 of approximately 4,000 student FTE.

Table 2 – Projected student growth at UC Merced and implications for faculty hiring rates over the next decade.

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Academic Year	Student Enrollment	Targeted Engineering Student Fraction	Resulting Engineering Student Count	Resulting S:F Ratio	Engineering Faculty FTE (total)	Anticipated Engineering FTE Request for Next AY
2005-06	875	15%	135	7	20.0	
2006-07	1190	19%	222	9	26.0	
2007-08	1815	17%	307	11	29.0	3.0
2008-09	2447	18%	440	13	35.5	6.5
2009-10	3002	19%	570	14	40.5	5.0
2010-11	3524	20%	705	15	47.0	6.5
2011-12	4084	20%	817	16	51.0	4.0
2012-13	4548	20%	910	17	53.5	2.5
2013-14	4968	20%	994	18	55.0	1.5

Source UC Merced Instructional Planning Office

At present, the number of students who have designated Engineering as their School of matriculation is 307 (Column 4). Thus, Engineering students account for 16% of the total UC Merced student population (Column 3). The resulting engineering student count in future years, derived from the projected growth in overall student enrollment and assuming a 20% engineering student fraction, is shown by year in Column 4. These figures do not take into account attrition of engineering students or selection of engineering as a major by students who are currently undeclared, since these figures are difficult to project given only one year's worth of data. Attrition of engineering students who entered UC Merced in AY 2005-2006 was 15%, far below the national average attrition rate of about 25% for first year engineering students. It should be noted that engineering attrition rates generally decline sharply after the Freshman year. With a current faculty of 29 FTE, the current undergraduate student faculty ratio (S:F) within the School of Engineering is 9 (Columns 6 and 5, respectively). This ratio jumped to 11 in AY 2007-2008 and continue to increase in subsequent years

While the School of Engineering employs a common freshman year, and as such does not hold students to initial major declarations made upon enrollment, estimates for matriculation across undergraduate majors over the planning horizon are shown in Table 3. These estimates are based on initial designations, and national trends in Engineering enrollments at other top Engineering programs and within the Engineering programs at other UC campuses.

Table 3– Anticipated distribution of students across Engineering majors over the 5-year planning horizon.

	2006-2007		2007- 2008		2008 -2009		2009- 2010		2010 - 2011		2011 - 2012	
	SoE Student Count											
Targeted Annual Enrollments for UCM[1]	**1190**		**1815**		**2447**		**3002**		**3524**		**4084**	
Percent Engineering	**19%**		**17%**		**18%**		**19%**		**20%**		**20%**	
Engineering Student Count	**222**		**307**		**440**		**570**		**705**		**817**	
BioE	23%	50	20%	62	20%	88	20%	114	20%	141	20%	163
CSE	36%	79	31%	96	30%	132	29%	165	29%	204	27%	221
EnvE	8%	17	10%	31	10%	44	10%	57	10%	70	10%	82
MSE	12%	26	1%	4	3%	13	4%	23	4%	28	5%	41
ME	1%	2	22%	69	23%	101	24%	137	24%	169	25%	204
Undeclared	23%	51	15%	45	14%	62	13%	74	13%	92	13%	106

[1] **UCOP Data**

2.2 Prognosis for Growth of Engineering Faculty Ratios

Because the size of the faculty within a school is effectively being dictated by the number of students working towards degrees in that school, two factors that are important in developing an estimate for the number of faculty FTEs that will be allocated to that school:

1. What is the total fraction of the student body that can be counted for that School; and
2. What is the desired student/faculty ratio within that School?

At the present time, insufficient data exist to be able to base such allocations on student success, or trends and norms for faculty productivity in other areas. Consequently—and because there is no direct mechanism at present for controlling Engineering student enrollments—an indirect means of influencing such an allocation is to consider what would be the most appropriate targets for these measures, and base the resulting request for faculty FTE allocations on these assumptions.

2.2.1 The desired fraction of Engineering students at UC Merced

Because UC Merced aspires to become a leading academic institution in all areas of scholarly endeavor that we undertake, and in particular because of our commitment to achieving the high status level of our sister campuses, it is important to consider carefully and realistically our goals for student recruitment and success. Specifically, a comparison among the Engineering programs at the 9 UC campuses having Schools of Engineering is presented in Table 4. Each column of that table displays current faculty and student data for each UC campus; faculty FTEs; graduate and undergraduate numbers for each engineering program; and for similar numbers for the campus as a whole. For example, the first column of Table 4 reports that engineering students at Berkeley (UCB) account for 13.4% of the total student population at Berkeley—resulting from 2,894 engineering undergraduates, and 1,590 graduate students—and that approximately 13% of the regular full time faculty at Berkeley are Engineering FTEs.

Reflecting the heavy emphasis on research within the School of Engineering at Berkeley, graduate students account for 35% of all UCB engineering students. In contrast, the fraction of graduate students within all departments at Berkeley is 30%. This general characteristic is

common across all UC campuses. Indeed, a very obvious characteristic of Engineering on UC campuses is a very strong emphasis on graduate research and education. Systemwide, the total fraction of engineering students who are graduate students is nearly 28%, compared with the fraction of graduate students in all other departments; 19%. The total number of graduate students assigned to faculty in the School of Engineering at UC Merced is currently 23.5 (10% fraction of all engineering students), with this number expected to increase significantly when two new graduate groups with a strong emphasis in engineering (Biological Engineering and Small-scale Technologies, and Mechanical Engineering and Applied Mathematics) became available in AY 2007-2008. For UC Merced to take its place among our sister engineering programs, we must place having a strong research program, with requisite need to develop research infrastructure to maintain that program, at the top of our list of priorities.

A similar comparison with other top engineering programs in the U.S. is consistent with the observation that the best engineering programs place a very strong emphasis on graduate research and education. Table 5 presents similar data for 10 top engineering programs in the US—our Comparison 10 universities. While the range is understandably larger, these top schools of engineering place a relatively greater emphasis on graduate research on their respective campuses than for other disciplines, at least with respect to the distribution of students. It is interesting to note that in contrast with the data for UC campuses, in general the fraction of students who are engineering students at these top institutions tends to be higher than within the UC—UCSD being a glaring exception.

The faculty of the School of Engineering at UC Merced has established a goal of achieving a level of 20% of total enrolled students with a corresponding—though yet to be defined explicitly—emphasis on graduate student fraction. Not only will this result in a very healthy research foundation for our student community, but will accelerate UC Merced's goal of enhancing economic growth in the Central Valley through the enhancement of its technical workforce.

2.2.2 Targeted student/faculty ratio within the School of Engineering

Tables 4 and 5 also contain data on the student/faculty ratio within engineering programs within the University of California and at the 10 of the top engineering research programs in the country (respectively). Because of the heavy emphasis at UC Merced on undergraduate declarations of academic major upon application, the student faculty ratio considering only undergraduate student numbers is presented separately from the corresponding ratio of all engineering students considered. For example at Berkeley, the student/faculty ratio considering only undergraduates is 13.3:1 whereas the overall ratio considering all engineering students at Berkeley is 20.6:1. In contrast, the current undergraduate student/faculty ratio in Engineering at UC Merced is 9:1, while the overall engineering student/faculty ratio is only slightly higher at 10:1. This is projected to increase to an undergraduate student/faculty ratio of 13:1 and an overall student/faculty ratio of 15:1 in AY 2009-2010. Our goal is to grow steadily yet deliberately to a level where the overall student/faculty ratio is in the low 20s, with the undergraduate student/faculty ratio in engineering being somewhere between 15:1 to 17:1

Maintaining a balance in growing these metrics at a gradual rate is important while the campus is in its infancy. For example, increasing the undergraduate fraction too abruptly would excessively burden the faculty during a time when they are already overloaded with

responsibilities of building the university. It is also important to note that regardless of the faculty to student ratio, courses necessary for students to graduate must still be taught. As a result, faculty at UC Merced currently have a high teaching load. The need for a parallel growth in graduate student numbers is not only important while faculty are developing their research programs, but to insure that we have sufficient numbers of graduate students to support our undergraduate programs (TAs, lab assistants, etc.).

Attaining this balance while maintaining the overall fraction of engineering students at 20% will, we feel, provide a robust and strategically positioned academic program, and one that will serve well both our undergraduate and graduate student populations.

Table 4 – Data on student enrollment in engineering within the University of California system (2005 data).

		UCB	UCD	UCLA	UCI	UCM	UCR	UCSB	UCSC	UCSD	System
Engineering	Undergrad	2,894	3,059	2,269	3,252	225	1,275	1,468	759	4,035	19,011
	Grads	1,590	1,116	1,256	995	22	291	694	274	1,147	7,363
	Total	4,484	4,175	3,525	4,247	247	1,566	2,162	1,033	5,182	26,374
	Faculty	218	176	150	154	26	73	125	66	166	1,128
	% UG	65%	73%	64%	77%	91%	81%	68%	73%	78%	72%
	% Grads	35%	27%	36%	23%	9%	19%	32%	27%	22%	28%
Campus	Undergrad	23,447	22,618	24,946	19,930	1,191	15,089	18,114	13,669	20,679	158,492
	Grads	10,036	4,051	10,771	3,774	76	1,965	2,905	1,344	5,121	39,967
	Total	33,483	26,669	35,717	23,704	1,267	17,054	21,019	15,013	25,800	198,459
	Faculty	1,671	1,450	1,692	839	90	610	781	542	984	8,569
	% UG	70%	85%	70%	84%	94%	88%	86%	91%	80%	80%
	% Grads	30%	15%	30%	16%	6%	12%	14%	9%	20%	20%
Engineering % of Campus	% UG	12.3%	13.5%	9.1%	16.3%	18.9%	8.4%	8.1%	5.6%	19.5%	12.0%
	% Grads	15.8%	27.5%	11.7%	26.4%	28.9%	14.8%	23.9%	20.4%	22.4%	18.4%
	% Total	13.4%	15.7%	9.9%	17.9%	19.5%	9.2%	10.3%	6.9%	20.1%	13.3%
	% Faculty	13.0%	12.1%	8.9%	18.4%	28.9%	12.0%	16.0%	12.2%	16.9%	13.2%
S/F R	Undergrad	13.3	17.4	15.1	21.1	9	17.5	11.7	11.5	24.3	16.9
	Total	20.6	23.7	23.5	27.6	9.5	21.5	17.3	15.7	31.2	23.4

2.2.3 Implications for faculty Engineering FTE requests

The faculty of the School has established a target schedule for extending and expanding our program consistent with those of the engineering programs at the other UC campuses, and those of the top engineering programs in the country. It is reflected in terms of a 10-year planning horizon as reflected within the shaded portion of Table 2.[ii]

With engineering students currently comprising slightly over 19% of the UC Merced student body, this places UC Merced in the upper quartile of UC campuses in terms of engineering emphasis during a time when UC Merced is making its mark as a university having a strong emphasis in the STEM areas.[iii]

Realizing the overall student growth based on the targets established for UC Merced, coupled with the decision by the faculty of the School of Engineering to maintain a total student fraction of 20% of students being engineers within the planning horizon, a framework is established that will guide the growth of our faculty numbers. Specifically, our student/faculty ratio will grow from a current level of about 9:1 to somewhat greater than

18:1 by the time our campus student population becomes 5,000 as specified in the original planning documents for the campus.

Table 5 – Data on student enrollment within the top engineering programs in the United States (2004 and 2005 data).

		UCM	UCB	GaTech	UIUC	UMich	Purdue	UCSD	UTAust	TAMU	UCLA	Wiscon
Engineering	Undergrad	225	2,894	5,200	5,329	4,874	6,049	4,035	4,553	5,930	2,269	3,137
	Grads	22	1,590	3,062	2,681	2,704	2,272	1,147	2,013	2,202	1,256	1,378
	Total	247	4,484	8,262	8,010	7,578	8,321	5,182	6,566	8,132	3,525	4,515
	Faculty	26	218	407	408	310	321	166	239	299	150	200
	% UG	91%	65%	63%	67%	64%	73%	78%	69%	73%	64%	69%
	% Grads	9%	35%	37%	33%	36%	27%	22%	31%	27%	36%	31%
Campus	Undergrad	1,191	23,447	11,842	30,452	25,467	30,851	20,679	36,478	36,227	24,946	28,217
	Grads	76	10,036	5,275	9,112	20,986	7,096	5,121	11,282	8,028	10,771	8,973
	Total	1,267	33,483	17,117	39,564	46,453	37,947	25,800	47,760	44,255	35,625	37,160
	Faculty	90	1,671	805	3,973	2,400	1,635	984	2,639	2,500	1,692	2,064
	% UG	94%	70%	69%	77%	55%	81%	80%	76%	82%	70%	76%
	% Grads	6%	30%	31%	23%	45%	19%	20%	24%	18%	30%	24%
Engineering % of Campus	% UG	18.9%	12.3%	43.9%	17.5%	19.1%	19.6%	19.5%	12.5%	16.4%	9.1%	11.1%
	% Grads	28.9%	15.8%	58.0%	29.4%	12.9%	32.0%	22.4%	17.8%	27.4%	11.7%	15.4%
	% Total	19.5%	13.4%	48.3%	20.2%	16.3%	21.9%	20.1%	13.7%	18.4%	9.9%	12.2%
	% Faculty	28.9%	13.0%	50.6%	10.3%	12.9%	19.6%	16.9%	9.1%	12.0%	8.9%	9.7%
S/F R	Undergrad	9	13.3	12.8	13.1	15.7	18.8	24.3	19.1	19.8	15.1	15.7
	Total	9.5	20.6	20.3	19.6	24.4	25.9	31.2	27.5	27.2	23.5	22.6

Blue entries in the table are 2004 data; all others are 2005 data.

After that time we intend to continue maintaining our student fraction at 20%, but will be well established enough to increase our student/faculty ratio well beyond that level as appropriate. Agreeing to do so prematurely would be detrimental to our overall academic stature and to our students. This is a strategy that is both responsible and achievable, and will result in a program that is both technically strong and sustainable, and will be one that will have a strong positive influence in expanding the technical workforce in the Central Valley.

The rationale discussed in Sections 2.2.1 and 2.2.2, and presented in Table 2, is based on growing the S:F ratio in the next few years to a level similar to other comparable universities. It suggests the allocation of 6.0 FTE new faculty positions for the next hiring cycle. However, regardless of student enrollment, a minimum number of faculty in each discipline are necessary to deliver the curriculum. Compelling arguments are presented in each major's section for a total hire of 13.5 FTE new faculty positions in SOE to adequately support teaching needs. Following a review of our current faculty authorizations, and a reconsideration of our proposed expansion of our academic programs, the specific description of these positions will be presented.

2.2.4 Workload Considerations

The academic planning model for the School of Engineering has been expended to include a consideration of faculty workload count as determined by the Office of the Registrar, and summarized in Table 6. It should be noted that the Registrar's data only reflects classes for which Engineering faculty are listed as the primary instructor. Engineering faculty participate in many co-taught courses, both those taught in other Schools and in the general education curriculum. Accordingly, faculty workload is underreported in this matrix and it is imperative that a mechanism of properly crediting shared teaching responsibilities be developed in order to accurately assess Student FTE counts. Anticipated Engineering student FTE count as presented in Table 2 over the planning period is repeated in the first row of Table 6. Normalized student FTE estimates—those student FTE teaching load units resulting from these actual student numbers—are presented in the second row of Table 6. Current

Table 6 Estimated student, faculty, and instructor FTE projections for the planning period.

	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011
Expected Student FTE	222	307	440	570	705
Normalized Student FTE1	367	400	560	660	760
Targeted Faculty FTE	26	29	35.5	52	60
Estimated Instructor FTE	2.0	3.0	5.0	7.0	8.0
[1] Includes students FTE for Introduction to Comping for NS and SSHA					

(Column 2), future (Column 3) and proposed (Columns 4 – 6), are presented in the third row of Table 6. Based on a detailed estimate of course offerings compared to anticipated teaching loads, including graduate course offerings within each discipline, row four of Table 6 lists the anticipated number of instructors that will be required to support lower division courses offered by the School of Engineering over this planning period.

Adjunct faculty are not included explicitly in this table because the few adjunct faculty we bring on will likely be involved in teaching upper division and graduate courses, and other specialized learning experiences not anticipated to be a regular contribution to our normal faculty workload. In many cases, adjunct faculty will be involved in co-teaching graduate courses with regular faculty, and engaging students with specialized directed reading or projects courses. In any case, the workload of adjunct faculty is not considered in the determination of instructors needed to deliver important elements of the lower division undergraduate program.

Faculty of the School of Engineering are, and will continue to be heavily and directly involved in the teaching activities of College One, including leadership of the Core 1 and Core 100 foundational general education courses; sharing the lecturing burden within these courses; participating equitably in the offering of freshman seminars; and sharing involvement in undergraduate research experiences consistent with the emergence of this program during the coming year.

2.2.5 Summary of current and authorized faculty FTEs (need update)

Searches currently in progress include 2.5 positions as a result of the AY2005-2006, strategic planning process (with 2.0 FTE Engineering allocations indicated by the non-underlined cells shaded yellow, and 0.5 FTE denoted as cross-School positions indicated by

the underlined cells shaded yellow in Table 7); and 3 positions allocated from the AY2006-2007 strategic planning process (shaded brown).

200-06-0108 Mechanical Eng

200-05-0109 Electrical Eng

200-06-0110 Bioengineering

200-07-0131 Bioengineering

200-02-0111 CSE (Systems)

200-07-0112 CSE

200-07-0113 Mechanical Eng/ Complex Systems

200-02-0114 Materials

200-05-0115 Environmental Engineering/Env. Systems (Air Pollution)

200-07-0116 Multiscale Modeling (Mechanical/Bioengineering)

200-07-0117 Sustainability Science (Environmental Systems)

200-07-0134 Cognitive Engineering

This format will be used in the following discussion and strategic plan for faculty hiring both for the 5-year faculty hiring plan, and the AY 2008-09 request for next years faculty FTE allocation (to be hired during Academic Year 2008-09 to be on board by the 2009-10 Academic Year. Additional columns will be added to denote that the corresponding faculty and positions will have responsibilities for launching new undergraduate majors. Descriptions of each position being requested within our 1-year FTE request will also describe research emphases of these individuals, as well as cross-School and cross-Engineering synergies.

Finally, these positions will be reflected explicitly within a revised strategic hiring matrix presented initially in Table 1, and revised in Table 10.

2.2.6 Faculty Diversity

Representation of women and minorities in the faculty ranks has been a high priority in the School of Engineering at UC Merced since its inception. Comparison data with other campuses for the percentage of women faculty members is shown in Figure 1, and that for Hispanic faculty members is shown in Figure 2. There are currently 19% women faculty members and 19% Hispanic faculty members in the School of Engineering. These numbers compare very favorably to those of other UC campuses and our comparison 10 universities. The School of Engineering continues to seek diversity among new faculty joining its ranks. This includes consideration of President's Post-doctoral Fellows in engineering disciplines that match hiring needs (although there are relatively few engineering Fellows awarded each year).

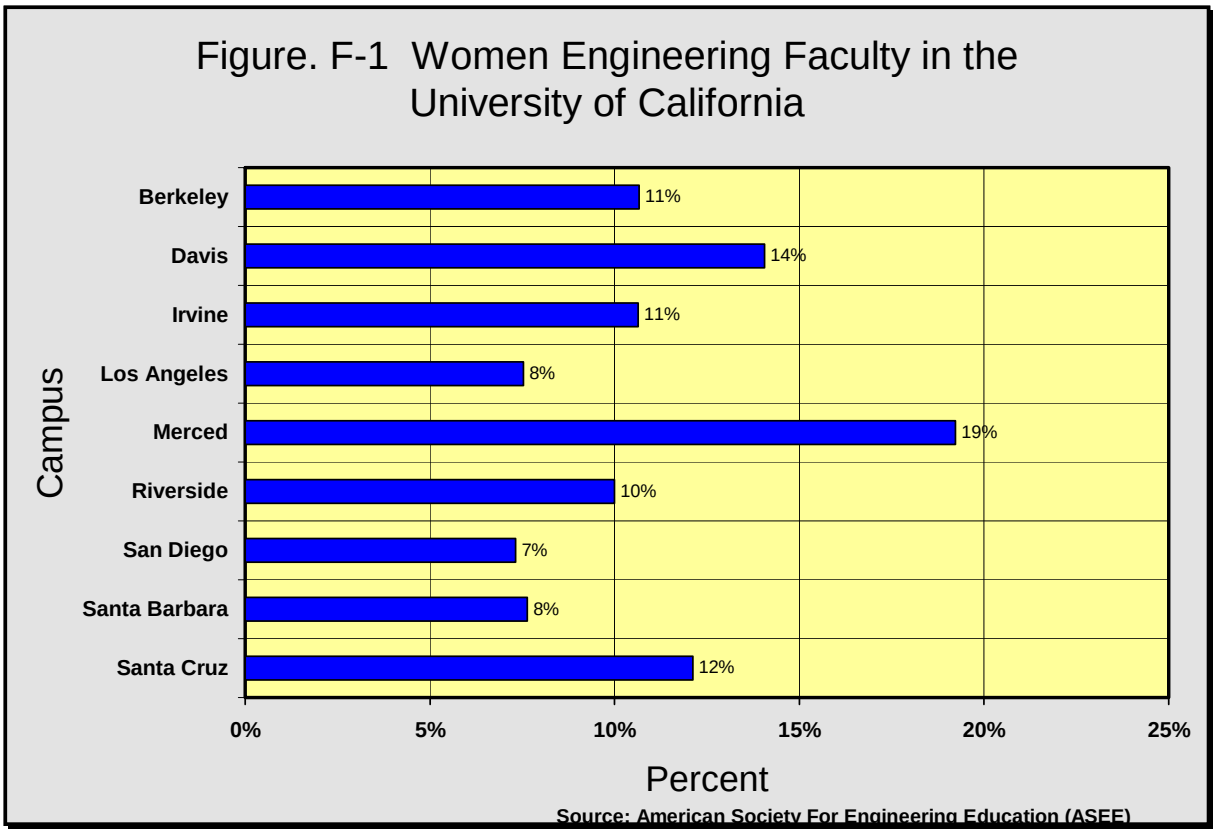
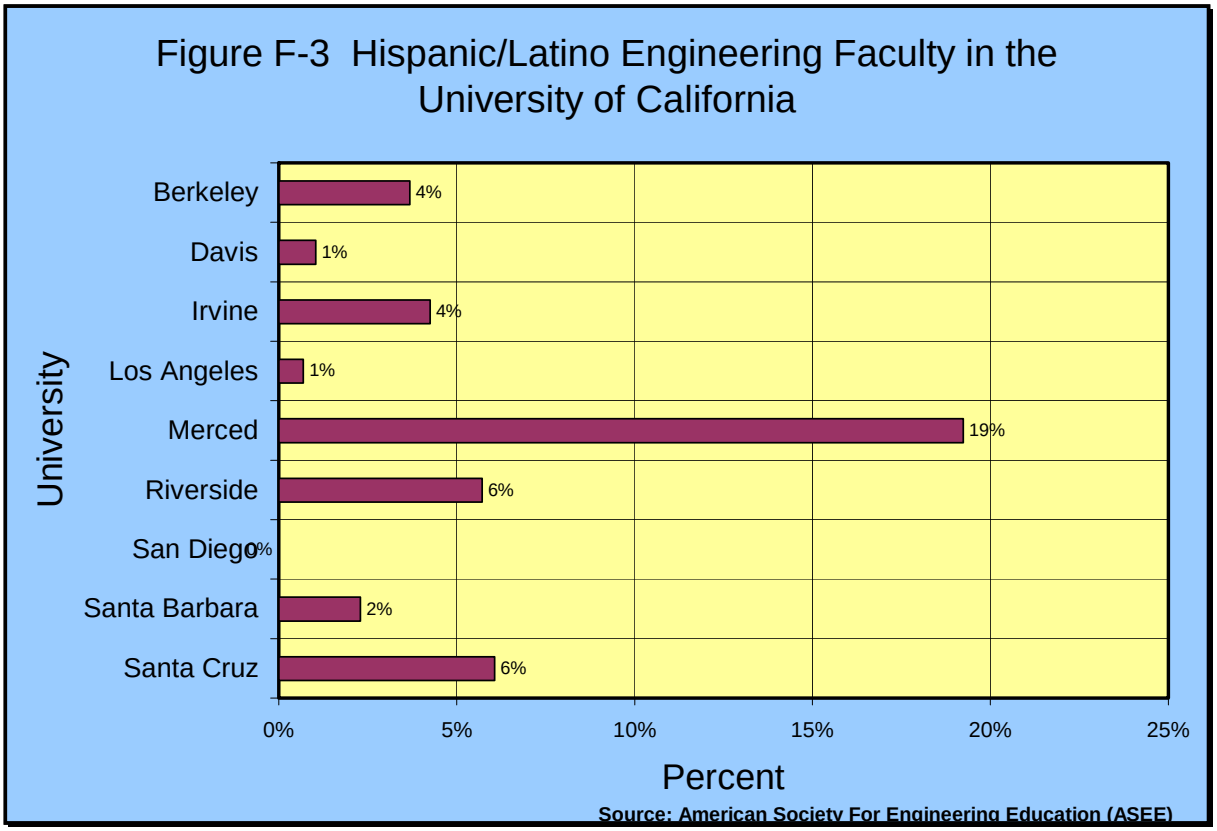


Figure 1 Comparison women faculty UC Campuses



2.3 5-year Plan for Expansion of Academic Programs

Table 7 – Status of School of Engineering faculty hiring reflecting primary disciplinary associations.

Academic Year	ENVE		CSE		BIOE		ME		MSE		EE		ChE		EEM		CE		Cumulaive Faculty FTEs
	Name	FTE	Name	FTE	Name	FTE	Name	FTE	Name	FTE	Name	FTE	Name	FTE	Name	FTE	Name	FTE	
	Bales	1.0	Newsam	1.0	Chin	1.0	Diaz	1.0	**Viney**	1.0	**Chiao**	0.5							
	Conklin	1.0	Kallmann	1.0	McCloskey	1.0	**Sun**	1.0	**Leppert**	1.0	**EE-2**	1.0							
	Harmon	1.0	Cerpa	1.0	Khine	1.0	Coimbra	1.0	Lu	1.0									
	Winston	0.5	Carpin	1.0	**(Escobar)**	1.0	**ME-4 (Fried)**	1.0	MSE-4	1.0									
	Guo	1.0	Carreira	1.0	**BIOE-5**	1.0	**(Modest)**		(Davila)	1.0									
	Rogge	1.0	Oh	1.0	BIOE-6	1.0	*Flex Systems*	1.0											
	Ervans(x)	*0.5*	Noelle	0.5	*Multi Scale*	0.5	*Multi Scale*	0.5											
	Westerling	0.5	CSE-8*	1.0			*Shen*												
	Chen	0.5	**CSE-9***	1.0			*Davinson*												
	Sustain	1.0	CSE-10(x)	0.5															
AY 05-06	5.5		6.0		4.0		2.0		2.0		0.5		0.0		0.0		0.0		20.0
AY 06-07	7.0		6.5		4.0		3.0		4.0		1.5		0.0		0.0		0.0		26.0
AY 07-08	7.0		7.5		5.0		4.0		4.0		1.5		0.0		0.0		0.0		29.0
AY 08-09	8.0		9.0		6.5		5.5		5.0		1.5								35.5
AY 09-10																			0.0
AY 10-11																			0.0
AY 11-12																			0.0

Underlined (x) denotes cross-School hire - *Italics* denote cross-engineering hires - (Paranthetical) entries denote individuals under consideration - **Bold** denotes senior FTE

	Future FTE
FTE	**Current searches**

AY 07-08 UG Enrollment	31	96	62	69	4				
Student Faculty ratio	3.9	10.7	9.5	12.5	1				
				Ratio does not include Shen and Davinson					

Our previous strategic plan called for starting two new majors during 2006-07 (Mechanical Engineering and Materials Science and Engineering), one new major during 2007-08 (Electrical Engineering), one new major during 2008-09 (Engineering Economics and Management), one new major in 2009-10 (Chemical Engineering), and one new major in 2010-11 (Civil Engineering). Budget and space considerations make this less likely than originally envisioned, and consequently we plan to delay the introduction of the Electrical Engineering, Engineering Economics and Management, Chemical, and Civil Engineering majors by one year. In particular, the dramatic shortfall in faculty FTE reduction from the allocation requested last year would, if continued this year and beyond, make even this schedule infeasible.

Adjustments to our 5-year hiring plan are based in part on a reconsideration of these future academic programs. Employment opportunities for graduating engineers in general, and those from disciplines being offered at UC Merced in particular, are expected to continue to be in high demand. Recent data from the Bureau of Labor Statistics indicate that the overall demand for engineers in all industries will increase by nearly 20% during the period of this planning exercise, with engineering jobs in the health service—including computational and information systems support areas—and medical instrument industries—including bioengineering, and several areas within mechanical and electrical engineering—forecasted to increase by more than 33%. Specifically, the 20 fastest growing professional jobs as reported by a recent issue of Fortune Magazine are displayed in Figure 3. Inaugural majors of the School of Engineering are well represented on this list. In addition, Mechanical and Electrical Engineering remain the largest engineering professions both nationally and globally, and are expected to continue to be so in the foreseeable future. While Materials

Science and Engineering is not anticipated to be large in terms of demand by undergraduates,

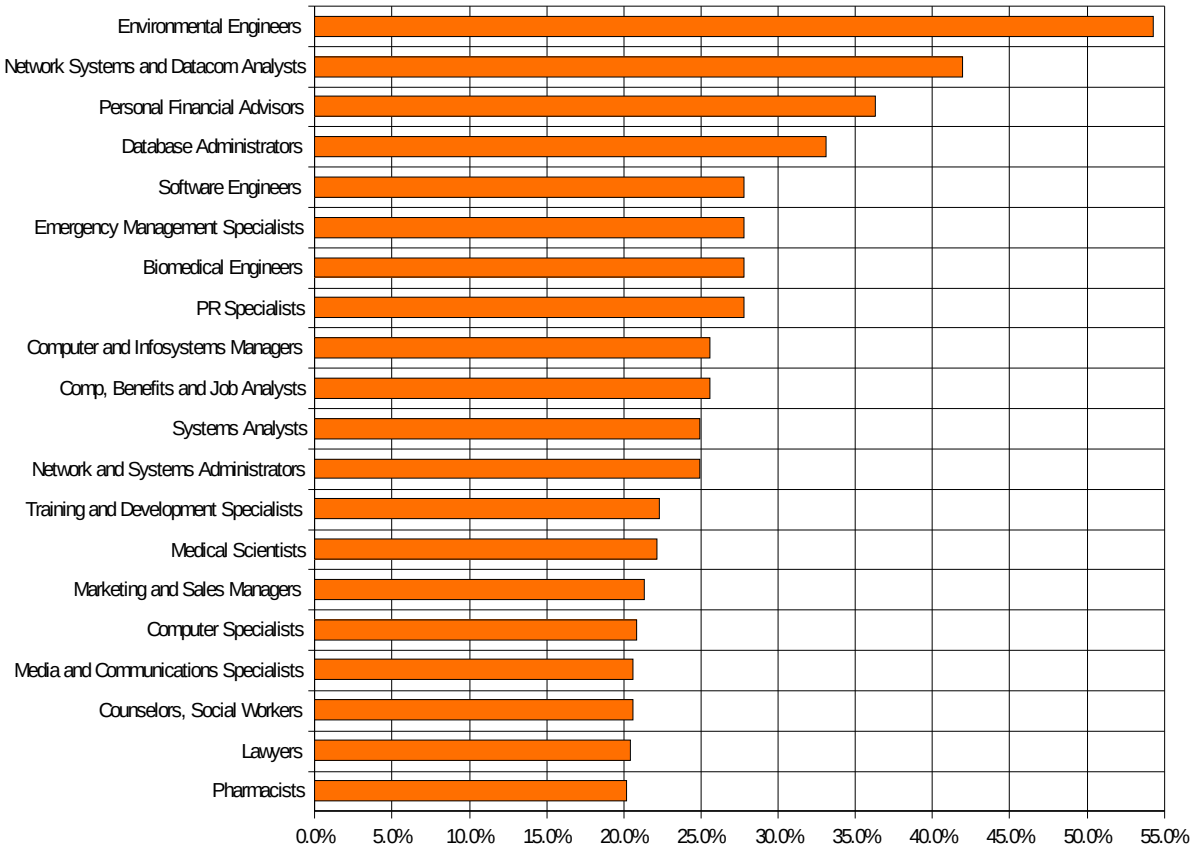


Figure 3: Twenty Most In-demand Professions Between 2002 and 2012 (Bureau of Labor Statistics)

the faculty who will support this major are key to the development of teaching and research programs in nanotechnology (an important and rapidly emerging technology sector), and will synergize extremely well with other emerging Engineering majors, with faculty and graduate student colleagues in the School of Natural Sciences at UC Merced, and those at other UC campuses.

2.3.1 Electrical Engineering

The School of Engineering at UC Merced currently offers an undergraduate degree in Computer Science and Engineering (CSE) and expects to offer an undergraduate major in Electrical Engineering (EE) starting in fall semester 2008. A search is currently underway for a Senior faculty member to guide development of the EE program, but introduction of the major has been delayed by one year due to current budget conditions. In order to better position these disciplines to attract and serve future students at both the graduate and undergraduate levels, and to attract research funding, the Engineering faculty has initiated a discussion about the possibility of merging the undergraduate programs in electrical engineering and computer science and engineering. While this discussion is still at the very preliminary stages, the implications for faculty FTE hiring could be significant. Thus prior to describing our 5-year hiring strategy, a brief discussion of the motivation for considering such a merger is presented.

There is considerable pedagogical motivation for a joint EECS program. The disciplines of CS and EE are clearly related. They are often considered as the endpoints of a linear continuum of disciplines that include CSE and Electrical and Computer Engineering (ECE), as shown in Figure 4.

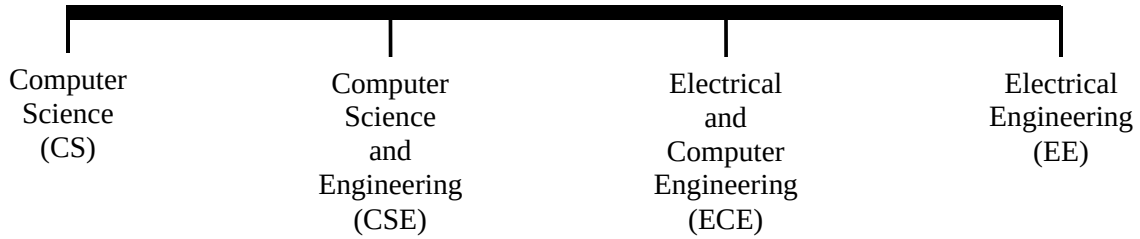


Figure 4 – Continuum of computational disciplines from Computer Science ←→ Electrical Engineering

Another, more revealing perspective posed by Edward Lee (professor and associate chair of EECS at UC Berkeley) and David Messerschmitt (professor of EECS at UC Berkeley) in their article *Engineering an Education for the Future*,[iv] views a circular continuum with three core areas as listed below and shown schematically in Figure 5:

1. Electronics (E)
2. Electronic information systems (EIS)
3. Computer science (CS)

And three overlap areas,

1. Computer hardware (E and CS)
2. Electronic systems (E and EIS)
3. Computer information systems (EIS and CS)

This joint EECS model supports two hallmark principles of the School of Engineering at UC Merced: (1) interdisciplinarity, and (2) common initial coursework that allows students to learn about and explore their interests. The boundary between hardware and software has been blurred through cross-fertilization such as software adopting modular components that were traditional to hardware—i.e., object oriented programming—and hardware becoming software-like via programmable logic. The opportunities for interdisciplinary work extend beyond the hardware/software boundary, however. Two of the three inaugural CSE faculty at UC Merced come from hybrid EE and CS backgrounds. Professor Newsam's research interests include image processing which exists at the boundary between CS and EIS. Professor Cerpa's research interests include computer networking and distributed systems, which also lie at the boundary between CS and EIS. The educational backgrounds of both professors include computer science and electrical engineering degrees, or hybrids thereof.

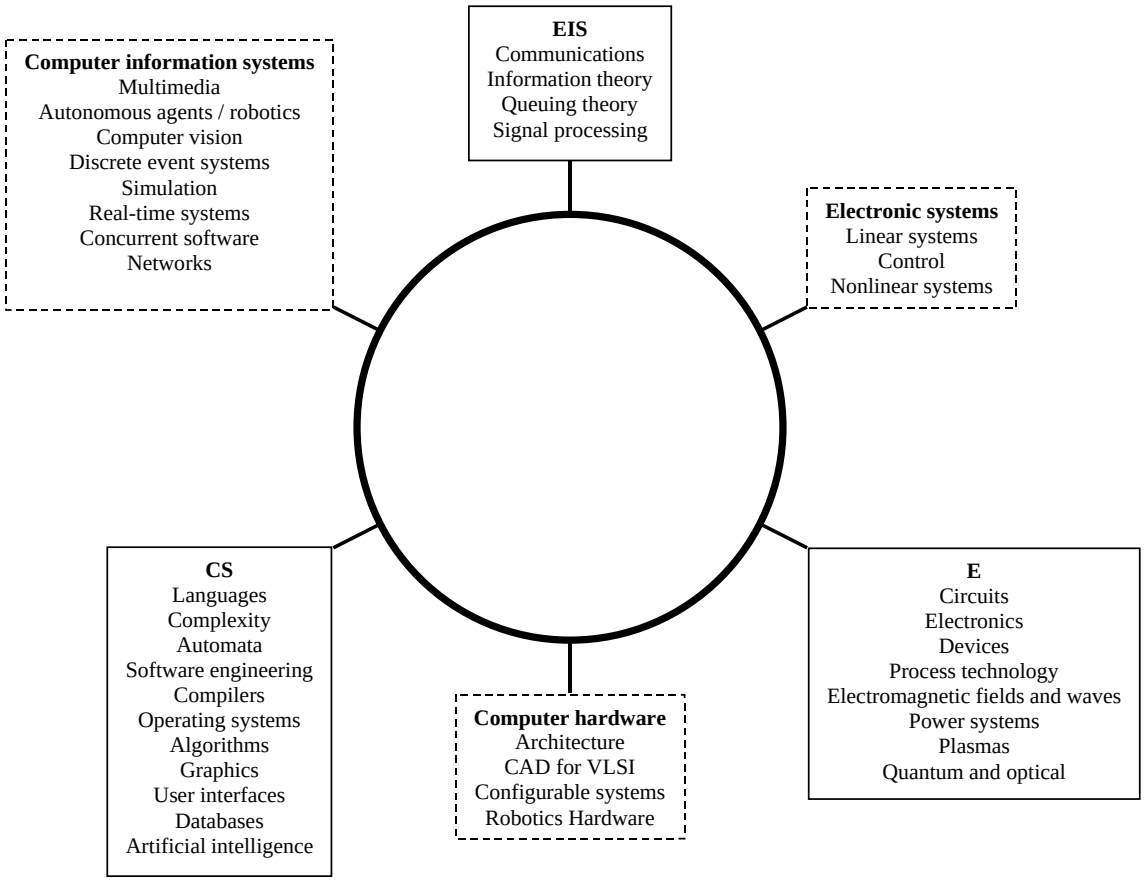


Figure 5 – A circular continuum along with sample topics. The core areas are shown in solid boxes and the overlap areas in dashed boxes.

The differences between disciplines in the EECS continuum is often confusing, especially to students seeing the topics for the first time. Just as it is unrealistic to expect graduating high school seniors to make a knowledgeable choice on undergraduate major, so too is it unrealistic to expect freshman or even sophomore college students to decide between CS, CSE, ECE, or EE. Having a joint EECS program with common freshman and sophomore years allows students to be exposed to a variety of topics from the continuum. This will prepare them to make a more knowledgeable decision about which emphasis or track to follow during their junior and sophomore years. We will likely consider a set of initial courses modeled on the recently revised EECS curriculum at UC Berkeley. Students in the EECS program would be required to take the following courses by the end of their sophomore year:

- CSE 30 – Introduction to object oriented programming and data structures
- CSE 31 – Systems programming and C.
- ENGR XX – Introduction to microelectronic circuits
- ENGR XX – Structure and interpretation of signals and systems

The ENGR course on microelectronic circuits is a modern, more digital version of a traditional circuits course. The ENGR course on signals and systems is modeled on a course

recently introduced at UC Berkeley that complements the circuits course to provide a better introduction to the EECS continuum.[v]

Additional arguments for a comprehensive consideration of merging these programs include:

1. Many of the top engineering schools at US institutions have joint EECS programs, including UC Berkeley, MIT, and the University of Michigan at Ann Arbor. Prior to a formal proposal to merge our programs, a comprehensive review of these programs will be made;
2. In addition to the pedagogical motivation, forming a joint EECS program at UC Merced probably makes sense from a resource perspective. Rather than struggling to hire the minimum number of faculty to support both CSE and EE degrees, the EECS program can spread to fill out the continuum as resources permit. The current CSE faculty lie on the CS to EIS arc of the continuum so this is a natural starting place for this growth; and
3. It would be significantly easier and more cost effective to form a joint EECS program initially that is later split, than vice versa.

Certainly many questions remain, such as what it means to have a joint EECS program at UC Merced where there are no departments. At larger, established schools, EECS is typically a department that offers either a single undergraduate degree (Berkeley offers only an EECS degree) or multiple degrees (MIT offers three degrees: Electrical Science and Engineering, EECS and CSE; and Michigan also offers three: EE, CE and CS). Offering only an EECS degree with several tracks (the Berkeley approach) would be the most straightforward way to achieve the objectives described above. However, other approaches might be possible. Another question concerns the relation of a joint EECS program to the yet to be formed graduate group that includes the current CSE faculty. Further consideration of a restructuring of our programs in CSE and EE will remain a major topic for discussion during the coming year.

2.3.2 Chemical Engineering

Our previous strategic plan reflected our intent to hire our first faculty member in chemical engineering in academic year 08-09, for roll-out of the major in 09-10. At the current rate of faculty hiring, bringing this major on this soon will come at the risk of having insufficient faculty personnel support for our current majors. Therefore, we propose postponing the roll out of this major until 10-11. Since chemical engineering is expensive in terms of both infrastructure and space, resource needs will have to be carefully considered. The chemical engineering curriculum requires sufficient support in space and personnel, especially in its required “unit operation lab” class.

Nonetheless, chemical engineering is an important component in the engineering portfolio of a mature campus. The motivation to plan *now* for UC Merced’s offering in this area is spurred by several factors:

4. Traditional ChE programs are converting away from the traditional areas of petroleum and bulk chemical processing to the scale up of biotechnological processes and specialized materials manufacture. UC Merced is in the unique position of being able to *start* a program in these strategic areas without having to dismantle an existing, unproductive, program or appease a “dead-wood” faculty;
5. UC Merced’s existing and planned engineering faculty already have a focus in the areas of biotechnology, materials, and nanoscale science that are mutually

complementary with strategic directions in ChE. The costs of bringing on a focused ChE degree program that complements the others would be less than that of restructuring an established program or starting a new one in a traditional, departmentalized environment;

6. Two of our existing faculty (Professors McCloskey and Chin) have undergraduate and graduate degrees in ChE that give them and us insights into the development of a cutting-edge program; and
7. We anticipate that existing synergies between Engineering and NS with respect to the chemical, biological and materials sciences will be able to grow to accommodate the teaching and research needs of a non-traditional ChE program.

2.3.3 Engineering Economics and Management

The undergraduate major in Engineering Economics and Management (EEM) is still under consideration. However, introduction of the major has been delayed due to budget uncertainties, as well as lack of clear information about the future development and growth of the management school.

2.3.4 Development of a Management Program and School

The School of Engineering (SOE) wishes to provide input into the planning of the School of Management (SOM). To help expedite success of SOM, we can leverage the research successes and strengths of SOE. Positions readily synergistic with the research thrusts of SOE and anticipated to be of particular benefit to both schools are: Technology Management, Entrepreneurship, and Natural Resource Management.

Below we provide a working definition of each of these research areas from the SOE perspective as well as a description of the type of faculty candidate most appropriate to head such areas.

2.3.4.1 Natural Resource Management

Natural Resource Management encompasses ecosystem management, habitat conservation, sustainable land management and water resources, with the goal of protecting, conserving, and rationally using natural resources. We proposed a Natural Resource Management focus within the SOM to advance our knowledge and understanding of our environment in order to develop innovative solutions to complex environmental challenges. Natural resources management employs a systems approach that combines and uses knowledge from natural science, engineering and social science to manage natural resources as an integrated system.

UC Merced's Sierra Nevada Research Institute provides the faculty expertise and unparalleled real-world research opportunities, including field work, in Natural Resource Management. Our location in the San Joaquin Valley near the Sierra Nevada offers an excellent and diverse real-world laboratory for studying the natural environment and how it is affected by human activity. It is envisioned that UCM would develop both undergraduate and graduate degrees in Natural Resource Management. The SoM would initiate the B.S.; initially, the graduate degrees could be offered under the Environmental Systems graduate group. At the graduate level, a number of discussions have taken place around starting a program in National Parks or Public Lands Management.

The Natural Resources Management program will be designed for students who are interested in pursing a career in both private and public sectors that engage in natural

resources management. The students who graduate from the program are expected to equip with necessary managing skills and solid understandings of how natural systems interact with human activities. We will focus on ecosystem stewardship, environmental governance, climate applications, policy and science, technology and its effects on the environment. While various foci should be considered, the following areas take advantage of capacity within UCM's existing schools: watershed, water resources, land, forest, public lands and wildlife management.

The demand for a workforce to carry out management of natural resources, including sustainable management, is always high as most resources used by human beings are depletable. Graduates of the program will be poised to pursue employment in a variety of federal, state agencies, non-profit organizations and the private sector. We expect the curriculum and aforementioned areas to qualify graduates for many state and federal jobs. Employment opportunities in California at the federal level include the, National Park Service, Fish and Wildlife Service, Forest Service, Geological Survey, Bureau of Reclamation, and Army Corps of Engineers. State and local level opportunities include various departments within the Resources Agency, water management agencies, parks and recreation departments, health departments, planning departments, and secondary school education. Non-profit and private sector employment opportunities include consulting firms, mining and lumber companies, and non-governmental organizations (e.g., Environmental Defense, Nature Conservancy, land trusts).

Natural Resource Management Position

This founding and leadership position requires a tenured faculty member at the full or associate professor level. Areas including global environmental issues (climate change, loss of biodiversity), critical natural resources (freshwater systems, forests), and health (air and water quality) are particularly encouraged. A research emphasis on water, forest, or range would compliment existing faculty and help fill an important niche in the UC system. The ideal candidate would have a proven track record in connecting their research with its social sciences and policy aspects and implications.

2.3.4.2 Entrepreneurship

Society depends on the advance of knowledge generated by scientists, engineers and researchers. However, entrepreneurs materialize this knowledge by undertaking innovative business plans. As an example, society's dependence on increasingly advanced materials, from lightweight yet strong composites for aeronautics to fiber optics for communications to bio-compatible materials for medical implants and drug delivery to silicon microchips for information storage and sensors, demands ever evolving new materials and the associated engineering processes for manufacturing them. Nanotechnology, the production of devices and machines at the molecular level, is heralded to drive the next technological revolution. This includes advances to enable: quantum information processing, orders of magnitude increase in strength of materials, and new strategies to address critical biomedical challenges.

As such, we feel it imperative to teach our students how to leverage the science and engineering fundamentals they learn by simultaneously providing them the real-world tools to do so. Entrepreneurship will draw on the research conducted by Materials Science and Bioengineering faculty and other disciplines in SOE. This position will be in the SOE. We will provide a framework for students to invent, develop new technologies, and recognize opportunities. As such, students will learn about intellectual property and patents, technology

and product development, discovery pipelines, the dynamics of innovation and technology management, risk management and regulatory compliance, and technology and start-up strategy.

Entrepreneurship Technology Position

This founding and leadership position requires a significant background in Materials Science, with also a demonstrated track-record in entrepreneurship. This will be the first Entrepreneurship position. The candidate should be well versed in topics including: advanced materials, biomaterials and bio-compatibility, nanotechnology, opportunity recognition, cost analysis, and manufacturing engineering. The ideal candidate would be a start-up veteran with a proven academic track-record.

The ideal hire for this position would have a background in MSE, allowing him/her to contribute to the teaching of engineering fundamentals and/or MSE core subjects. Their research area would have to be consistent with the goals of the BEST graduate group. This person would additionally have significant experience in the corporate world, of taking intellectual property past the concept stage to material or device fabrication. At UC Merced, the successful applicant would develop strong links with our economics and management programs, helping to create a degree pathway that emulates the successful MEM program at Oxford. Because it is likely that the candidate will have had limited teaching experience, an appointment to the assistant or associate professor ranks would be anticipated.

While detailed laboratory needs will emerge when strong candidates are interviewed, we again expect that considerable space use efficiency will derive from our ongoing efforts to develop shared facilities for nanofabrication and characterization.

2.3.4.3 Management of Technology

Management of Technology involves the operational and organizational issues associated with managing: innovations of the 21st century, information technology, environmental issues, and entrepreneurship in high and bio-technology. UCM's proposed *Management of Technology Joint Management & Engineering Program* seeks to employ rigorous research methods, including optimization, simulation, and empirical approaches, in a comprehensive and multidisciplinary framework to teach our students how to develop, plan, implement, and assess the technological capabilities which shape the strategic and operational objectives of organizations.

To help launch the Management School, we feel that one initial, effective focus would be on Management of Information Technology, to leverage the expertise of strengths of the Computer Science Faculty within the SOE. Information Systems Management focuses on the collection, processing, storage, distribution and utilization of an organization's information resources. According to the US Department of Labor, Bureau of Labor Statistics, employment of computer and information systems managers is expected to grow faster than the average for all occupations through the year 2016. Because Information Systems Managers must possess a solid mix of business and technical knowledge to understand organizational structures, objectives, operations and the resulting financial implications, we must have a comprehensive and rigorous program in which our students will be equally trained in the math and science fundamentals of computer science as well as in understanding

the environment in which their solutions will be applied, through economics and business courses.

Only by understanding both these facets can our students communicate effectively with users to design systems that support their needs.

Management of Technology Position

This founding and leadership position requires a broad and significant background in engineering and also in business/economics or related field, a demonstrated record of successful teaching, plus extensive research experience in academia and industry, with strong ties to industry. The ideal candidate should be well versed in topics including: systems development tools and techniques, information architecture, network configurations, databases structures, systems integration, knowledge management, technology development and process improvement, and performance measurements and technology drivers. This person could initially contribute to graduate education through the EECS graduate area.

2.3.4.4 Energy, Climate, and Sustainability

Our state, nation and world face unprecedented challenges in developing sustainable solutions to the global environmental problems associated with the production and consumption patterns that have developed in our industrial societies. Climate change is perhaps the most difficult problem that today's society and nations must solve. The knowledge base for finding solutions is particularly weak and effective policy resolution remains unknown. Thus, significant research is needed. In summer 2007, the UC campuses together submitted a $600 million proposal to the California Public Utilities Commission for a Climate Solutions Institute, intended to be the focal point for research on energy, policy, climate applications and related research to help California meet the goals of AB32, which commits the state to major reductions in carbon emissions. Research and education at the intersection of energy, climate applications, environmental sustainability and technology management will be a strong growth area for coming years and decades, and represents an opportunity for UC Merced. Other UC campuses are not far ahead of UCM in this area, and we can develop visible, well-respected programs in a relatively short time.

Universities across the nation are either considering or developing academic programs in sustainability, with energy and climate being the central themes. An SoM focus in this area can help faculty and students who develop technical solutions to put these in a business context. Entrepreneurship will be a key ingredient of a focus area in energy, climate, and sustainability at UCM. It is expected that sustainability could be an undergraduate focus area in the SoM, as well as a graduate degree track.

Energy, climate, and sustainability management position

This founding and leadership position requires a tenured faculty member at the full or associate professor level. Preference should be given to someone with a strong foundation in engineering or science, but with a track record of research in management or policy. Areas of interest for the founding faculty member include energy management, carbon management, sustainable infrastructure or climate applications. The person could initially attract graduate students through the Environmental Systems graduate group; though in the longer term, a more management-oriented graduate group should be formed.

2.3.4.5 Biotechnology Management

According to the National Science Foundation, the need for biotechnology workers is out-pacing the rate at which US universities are producing graduates. Biotechnology, loosely defined, incorporates techniques that leverage the characteristics of living systems for products or services. Because universities cannot satisfy industry's demand for new PhD graduates, attracting and retaining trained employees is increasingly a serious challenge. This problem specifically impedes, for example, the drug development process. In shortest supply are trained biologists to make discoveries, research engineers to develop the discoveries, and managers to plan and execute clinical trials.

Management programs designed to teach the requisite knowledge and skills for life science commercialization are therefore needed. Instead of creating another generic program in which students learn broadly about marketing, we can specifically train our students in growth areas to ensure their own marketability upon graduation. In particular, we have a unique opportunity because of Prop 71, a California statewide ballot measure passed in 2005, providing $3 billion in funding for stem cell research at California universities and research institutions (other states are considering similar legislation). Because we have this jump-start to address this burgeoning and rapidly growing field, we can develop a unique certificate program to specifically train our students in the requisite skills to help realize the long-heralded potential of stem cell research. We can develop a unique Biotechnology Management Track and an eventual major by piggy-backing on the research strengths of our biomedical scientists and engineers.

Biotechnology Management Position

This hire would be able to fit into several graduate groups, including BEST and QSB and bring unique and industry relevant research to UC Merced. This faculty member will not only teach our students the basic science and lab skills, but also the ethical, legal, and financial ramifications of their decisions. They will be taught about strategies and can attain real world practice through commercialization of existing research projects here.

2.3.4.6 Center for Entrepreneurship

Whether under a School of Management, engineering or jointly administered, a Center for Entrepreneurship would have a number of core features. We have already implemented an entrepreneurial aspect to Service Learning, by encouraging students to develop innovations to address the needs of their clients. The scope of the projects includes not only the engineering aspects, but also issues associated with a real nascent venture, including: opportunity recognition, intellectual property issues, competitive analyses, team formation and management, and fund-raising/financial management. This semester we are also introducing our first entrepreneurship course, BioEntrepreneurship (Eng 108, Eng 208). Other areas to pursue under an Entrepreneurship Center include:

- provide courses on product design and development
- educate students about intellectual property /enable ease of tech transfer
- build and support cross-disciplinary teams for technology and product development
- offer internship and fellowship opportunities with start-up companies, industry leaders, and venture capital firms
- offer students consulting opportunities
- provide real-world entrepreneurs as mentors (we are assembling a board of high-profile mentors)

- train our engineering and life science students in the business aspect of innovation and management
- promote industry connections and involvement with this campus
- offer incubation of companies that are developed from this campus
- stimulate and promote new industry in the San Joaquin Valley area

By teaching both the technical and entrepreneurial skills in parallel, we will uniquely arm our students to be competitive in today's workforce. By offering the opportunity to implement these skills in a real-world environment, we are providing the experience critical to become successful or "seasoned" entrepreneurs. Finally, by developing an interdisciplinary, nurturing, and entrepreneurial-promoting environment, we will offer our students and faculty the greatest probability of success with respect to their ventures.

2.4 Request for School of Engineering Faculty Positions for 2008-09

The 13 faculty FTEs being requested by the School of Engineering for the next faculty hiring cycle are shown in Table 8 as pink shaded cells corresponding to AY 08-09. They are ranked in order of priority within the major, and ranked by order of priority within the School of Engineering in Table 9. The faculty of the School of Engineering as a whole ranked the FTE requests shown in Table 9 and approved the ranking and adoption of this Strategic Plan in a vote taken at the January 15, 2008, SOE faculty meeting. Of 23 faculty eligble to vote, 18 voted YES, 0 No, with 5 absent. FTE requests were triaged into 3 categories - critical hires required for existing large enrollment majors to deliver the curriculum; high priority additional hires necessary to sufficiently staff majors, focused on UC Merced research pillars; and regular priority additional hires necessary to sufficiently staff majors. Within each category, FTE lines are listed with equal priority. The faculty of the School of Engineering recognizes that under the present fiscal conditions, we are unlikely to be allocated all the requested hires. However, we feel it imperative to articulate the reality of our hiring needs. Descriptions of major specific positions are presented in Sections 2.4.1 through 2.4.5, Cross-engineering positions (shared by more than one engineering major) are presented in Section 2.5 and cross-school positions are presented in Section 2.6. Filling our current positions and these 13 new positions would bring our total engineering faculty FTE to 55.5.

Bioengineering

To deliver the BIOE major in its currently proposed, we need to cover 26 specialist credits. 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 major includes 4 existing and 2 approved FTEs who are realistically available to deliver the above mentioned 26 specialist BIOE 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 we do not have the minimum number of faculty FTEs to deliver the major. In addition, we have initiated BEST (Biological Engineering and Small-scale Technology) graduate group in the fall semester of 2007. We also need to provide two required graduate courses and sufficient advanced elective classes (3-5) for BEST students.

Three future FTE directions have been identified by the faculty in BIOE (listed in the priority order).

1. Tissue Engineering

2. Physiological Modeling

3. Single Cell Quantitative Measurements

2.4.1 Bioengineering: Tissue Engineering

The field of tissue engineering is an emerging and ambitious area of research in which scientists seek to build devices that would replace diseased tissues/organs with their biological equivalents, thus completely restoring tissue/organ functionality. This area has been termed Tissue Engineering and/or Regenerative Medicine. The area of tissue engineering is, by nature, cross disciplinary in that it employs cell culture methods combined with appropriate materials, scaffolding architecture, technologies for cell delivery, and nutrient transport strategies while also synergizing with nanobioengineering by employing the use of small nanoparticles or nonocomposite scaffolding materials. For this reason, the tissue engineer would also be expected to contribute significantly to our undergraduate program in Materials Science.

The Tissue Engineering position could also compliment and synergize with the research of a number of faculty in the areas of Stem Cells, Vascular Tissue Engineering, Biomaterials, 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 Program at UCM.

2.4.2 Bioengineering: Physiological Modeling

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 human level. Systematic modeling incorporating various engineering concepts such as optimalization, 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 a interdisciplinary field between engineering and biology, BioE has a strategic advantage in engineering to address this unique challenge and opportunity.

Current most faculty members in bioengineering at UCM are in experimental-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 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 can not be addressed from the view point of a single discipline.

The space need for this position is expected to be dry lab space around 400 sq ft. This faculty member is expected to teach undergraduate classes in bioengineering and graduate classes in BEST graduate group.

2.4.3 Bioengineering: Single Cell Quantitative Measurements

Recent developments in optical techniques (particularly laser manipulation, quantitative fluorescence microscopy, ultra-small volume sampling and analysis, incorporation of optically useful probes, and optical approaches to determining the rates and equilibria of intracellular processes) clearly indicate the enormous potential of in vivo single cell studies for our understanding of cell physiology. Single-cell detection technology should allow researchers to target individual molecules within the cell, track where they are going, and record changes--all without significantly interfering with cellular physiology. Due to its highly multidisciplinary nature, single-cell detection technology presents a unique opportunity for Engineering at UCM. Our unique campus environment is an ideal location to cultivate single-cell detection technology. This research area will apply tools in optics, microfabrication, microelectronics, nanotechnology and analytical chemistry to small volume detection inside an individual cell. The development of such technology enables many research and industrial applications such as single-cell manipulation, high throughput screening, improved diagnosis tools, single-cell genomics and proteomics. This research area represents an outstanding opportunity to involve faculty members in natural sciences, optical physics, bioengineering, materials science and engineering, mechanical and electrical engineering in a cross-disciplinary project. It is proposed that this position will be designated at the rank of full professor.

This position would compliment and synergize with the research of a number of faculty in many areas of research. We also expect that this faculty hire would contribute to our growing needs in developing assays or tools for analyzing single cells. Single cell analysis is a much needed tool for the advancement of many fields including Systems Biology. Therefore, this cross-school position compliments the growing needs for graduate programs such as BEST or Quantitative and Systems Biology.

Computer Science Engineering

We request a minimum of 3.5 full FTE positions to be assigned to CSE. After ample internal discussions the CSE faculty unanimously agreed on the following prioritized list for the 2008-2009 strategic plan.

2.4.4 Computer Science Engineering: Instructor with security of employment.

We request one instructor to permanently teach the undergraduate courses CSE5, CSE20 and CSE21. These introductory courses attract large number of students and are time consuming to teach and prepare for research faculty. A dedicated experienced instructor is the best option in order to optimize the resources needed to offer these classes. An additional duty of

the instructor will be to coordinate and supervise the content of the other lower division CSE courses, i.e. CSE30 and CSE31. In recent semesters lower division CSE courses have been offered by temporary instructors, often hired under time pressure. The persistence of this situation hinders the development of a strong undergraduate CSE program, due to the fluctuations in content and possible lack of coordination deriving from this situation. The role of the instructor will be therefore critical to improve our existing curriculum. Considering that the three aforementioned courses are not specific to the CSE major, but are rather taken by all engineering students (CSE 20 & 21), or from the other schools (CSE 5), we propose that this position will be counted as a 0.5 FTE against CSE.

2.4.5 Computer Science Engineering: Senior position complementary to existing CSE faculty with research emphasis in CS.

This position is needed to broaden the CSE program both for teaching and research. We recently successfully hired two junior faculty members in the areas of machine learning and intelligent systems. With the goal of creating a very strong research group within a few selected domains instead of growing in all directions, this position will aim to the same domains targeted in the past, i.e. AI/Graphics, Systems, and Data Analysis/Data management. The current searches are still somewhat broad, and there is a possibility that not all of the target domains of the current searches will be covered successfully or sufficiently by the candidate hired. If there is sufficient coverage, however, the new core research areas that will be targeted include languages, compilers, operating systems, computer networks, embedded systems, and algorithms. Considering the current composition of the CSE faculty, i.e. 6.5 assistant professors, it is imperative to hire a senior faculty member in the CSE program. Two searches for senior faculty members are open at the moment. With this additional senior position the CSE group will reach a viable distribution of ranks. The space needs for this new position are expected to be similar to those of the current CSE faculty; a modest level of dry lab space for several computer and/or experimental research workstations. The exact space needs will depend on the rank of the position.

2.4.6 Computer Science Engineering: Senior position complementary to existing CSE faculty with research emphasis in EE.

This position is needed to build the Electrical Engineering undergraduate major under planning. Moreover the graduate study area formerly called Computer and Information Systems has been recently renamed Electrical Engineering and Computer Science. This new position will therefore be instrumental not only to jumpstart the undergraduate program in Electrical Engineering, but also to strengthen the graduate program being developed at the moment. Considering the current situation in Electrical Engineering, i.e. one open search with broad scope, we feel the new search should be broad as well. Targeted areas should include the following: systems,communication, signal processing, wireless technology and networking, RF hardware, control, circuits and sensors The space needs for this new position will depend both on the rank and on the research area of the selected candidate.

2.4.7 Computer Science Engineering: Senior position complementary to existing CSE faculty with research emphasis in EECS.

This position will be instrumental to bridge possible research and teaching gaps between Electrical Engineering and Computer Science. Possible research topics include, but are not limited to, embedded systems, robotics, sensor networks and the alike. The space needs for

this new position will depend both on the rank and on the research area of the selected candidate.

2.4.8 Computer Science Engineering: Media Arts and Technology (MAT) (Cross-school)

Media Arts and Technology (MAT) is an interdisciplinary area that fuses emergent computer science and engineering, and digital art research, practice, production, and theory. MAT offers the opportunity for working at the frontiers of art, science, and technology, where new art forms are born and new expressive media are invented. The highly crossdisciplinary nature of this exciting field, and the direction being taken at UC Merced with key faculty hires within the School of Engineering and the School of Hunamities, Social Sciences, and Arts, suggest that this is an excellent opportunity for innovation at UC Merced.

Environmental Engineering

2.4.9 Environmental Engineering: Junior or Senior Hire Environmental Microbiology.

We recommend an open-rank search in, with a research focus on any of several areas, e.g. environmental remediation, environmental contributions to infectious disease or characterization of microbial communities in natural and engineered systems. Last year both the SoNS and SoE strategic plans identified environmental microbiology as a critical hire in order for UCM to achieve national competitiveness in a number of research areas. Leading environmental research programs in the nation include a strong core subgroup of environmental microbiology and microbial ecology, typically 2-3 investigators. Environmental microbiology was deemed critical for emerging research strengths in global change ecology, in biocomplexity, bioremediation, and in climate and watershed science. This position would provide critical synergy with the successful candidates in ecology currently being searched in SoNS, particularly in the microbial ecology area. This individual is necessary for creating the kind of modern undergraduate environmental engineering program that will attract the best and brightest students to this field, for undergraduate teaching in environmental engineering and for accreditation of the degree. The ES graduate group also identified the position as important for recruiting graduate students and offering appropriate courses. CAPRA recommended the position.

2.4.10 Environmental Engineering: Junior or Senior Hire in Ecohydrology and 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. As a discipline, ecohydrology addresses the bi-directional regulation of hydrologic and ecological processes, e.g. the flow regime and pollutant levels of water in wetlands regulate the species and the populations that live in the ecosystem, while ecological processes in the wetland regulate the timing and magnitude of water and nutrient fluxes through the system. Ecological engineering involves the design, construction, restoration and management of aquatic and terrestrial ecosystems that have value to both humans and the environment, using

principles from engineering, ecology, economics, and natural sciences. 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 and across the Western U.S.

Materials Science Engineering

"Materials Sciences" has been identified previously as a cross-School priority, and "Materials Technologies" as a priority within Engineering. A nanoscale trend is also emerging as an area of interest that intersects MSE, BIOE, ME, ChE, Life Sciences, Physics and Chemistry, as well as SNRI (forest fire generated nanoparticulates) and the Energy Program (quantum dot photovoltaics and nanostructured fuel cells/batteries). MSE and BIOE, in particular, are building a strong research program in bionanotechnology, as evidenced by the continued development of the Biological Engineering and Small-scale Technologies graduate group. Bionanotechnology is a research area of great current interest that encompasses fields such as tissue engineering, nanoscale/microscale electromechanical systems, biosensing, and bio-inspired nanoscale materials synthesis and processing. Funding for it by granting agencies ranging from the National Science Foundation to the Department of Defense, and private industry, is rapidly growing; and it strongly contributes to the strength in biomedicine that UC Merced is building.

Faculty in MSE are also contributing to the proposed research theme in free radical biology. Reactive oxygen and nitrogen species (which includes free radicals, such as superoxide and nitric oxide) play essential and ubiquitous roles in biology. An interdisciplinary group composed of faculty and students in QSB and ES has formed a center that focuses on the role of oxidants and other electrophiles in both damage to organisms and in normal physiology. The present and proposed work includes studies of redox cycling in the environment, environmental and health hazards of nanotechnology, photobleaching of coral, how Hepatitis C infection is modulated through redox signaling, how elephant seals avoid oxidative stress that results from extreme environments, how growth factors act through redox signaling, and understanding the recognition of oxidants important to inflammation with the goal of designing anti-inflammatory pharmaceuticals. In particular, since MSE has a research concentration in nanoscale materials, its faculty contribute important nanoscale materials characterization and chemistry expertise to this effort.

MSE as a discipline intersects many areas of environmental interest. These include: (a) new, energy-efficient, cost-effective routes to raw material extraction and recovery (the FFC Cambridge process for material production, http://www.msm.cam.ac.uk/djf/FFC_Process.htm, demonstrates the revolutionary impact that MSE can have in this regard); (b) the effect of changing ozone levels and climate on the durability of construction materials; (c) materials use in energy conversion, distribution and storage; (d) materials for communication and transportation infrastructure; (e) whole life-cycle design with recyclable materials. Given its existing "green" credentials and continuing aspirations, UC Merced can (should!) become an international leader in sustainable materials technologies.

Faculty in MSE are developing innovative experiences in undergraduate education, a key component of our goals to put UC Merced at the forefront of 21st century materials technology. A recent grant awarded by the National Science Foundation will enable us to offer undergraduates the opportunity to learn microfabrication techniques and practical

nanotechnology, and to extend the experience to students (= potential recruits) from Merced College.

Undergraduate students at UC Merced have expressed considerable interest in MSE. Freshman seminars have been oversubscribed and, consistently, very well attended. Numerous conversations with students suggest a chicken-and-egg situation in which students are drawn to the subject, but are reluctant to declare MSE because they perceive that there are not yet sufficient FTEs to deliver the major. We also anticipate that some students (those who find themselves less mathematically inclined but who have strong conceptual and spatial skills) will migrate from ME and also EE to MSE. This has been the experience at many established universities; ME or EE recruits the students to campus, and MSE helps to keep them there. In this way, an active MSE program strengthens the ME/EE programs and boosts retention.

From the point of view of delivering the approved major in MSE, which has been designed to meet ABET accreditation standards, a "core" of 26 specialist credits needs to be covered, and there are also some technical electives that MSE should contribute to the "pool" of courses that are presented to students in MSE, BIOE, ME and Chemistry. A bare minimum of 5 FTEs is needed to run the major based on these teaching and accreditation requirements. The proposal for a minimum of 5 FTEs allocated to this major is also consistent with the original plans that formed the basis for approving the major. There are currently up to 4 approved FTEs (Professors Viney, Leppert and Lu, and a fourth hire currently open) associated directly with this major. Two are at the senior level and two at the junior level. However, Viney and Leppert continue to be very heavily involved in other programs that are essential to the success of the School, including the Engineering Fundamentals course ENGR45 (Introduction to Materials), General Education, Engineering Service Learning, the Center Of Integrated Nanomechanical Systems (COINS), and the Imaging and Microscopy Facility. Therefore, we are requesting an FTE (emphasis: complex materials) at the Senior level.

We are also keen to capitalize on the unique opportunities afforded by the already strong economics program and the nascent School of Management at UC Merced. Specifically, we would like to emulate the successful program at Oxford which allows the very top students in Materials (as assessed after the freshman year) to major in Materials, Economics and Management (MEM). The approximate coursework composition is 60% Materials, 20% Economics and 20% Management. The Oxford program recognizes that captains of industry in Europe's and Asia's more successful economies are not lawyers or accountants, but PhD engineers or scientists. Graduates of the program are highly sought after. We envisage that such technical representation in the highest levels of industry will become increasingly necessary as manufacturing based on – and producing – complex technologies increases. It will be especially relevant in the context of UC Merced, which is expected to perform the dual roles of inventing technologies and encouraging local entrepreneurship to implement the inventions. Accordingly, we propose hiring an FTE (at the level of assistant or associate professor) who can thrive at the intersection of engineering and entrepreneurship.

2.4.11 Materials Science Engineering: MSE-6: Complex Materials

An FTE in complex materials will contribute strongly to both our teaching and research missions. The person hired will have an accreditable background in materials and be able to deliver essential courses that are core to the discipline, plus technical electives. On the research side, Merced would benefit from enhanced expertise in new materials that meet

nanodevice fabrication, or high temperature material for use in energy conversion, or nanomaterials with novel physical, chemical and mechanical properties. A hire in any one of these areas will considerably strengthen at least two of the research focus areas targeted for strategic development by the School of Engineering: Energy and Materials Technologies, and Nanoscale Systems. A hire who (our preferred choice) *combines* experiment and modeling could enhance the collaborative opportunities for an additional two of the areas targeted by SOE: Computational Sciences and Engineering, and Modeling Sciences. The term "Complex Materials" reflects the fact that simultaneous control of multiple properties requires molecular order to be controlled simultaneously at multiple length scales. Depending on the area of expertise of the person hired, it is likely that he or she may also contribute to strategic research efforts in Environmental Science and Engineering or Biological Engineering.

We propose a hire at the Senior level for this position. Laboratory needs will be unexceptional, and will depend on the area of the strongest candidate who emerges from the search. Space use efficiency will benefit from our ongoing efforts to develop shared facilities for nanofabrication and characterization.

Mechanical Engineering

The mechanical engineering (ME) undergraduate major was launched during Fall 2006 accepting only freshman students. The plan is to start accepting transfer students for 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 this major before they complete their degree. There is increasing evidence that ME will become one of the most popular engineering majors at UC Merced. For instance, out of 300 freshman students accepted in engineering for fall 2007, 53 students (17.7%) chose ME. Last year, a significant fraction of the undeclared students decided to enroll in ME, so we expect a similar trend for this year.

Although there are some fundamental topics that relate to mechanical engineering, such as mechanics, design, manufacturing, strength of materials, transport phenomena, controls, etc., we emphasize that this discipline adapts and grows as new technologies emerge. Cutting-edge research in biological systems, nano- and micro-scale devices, sustainable energy systems, intelligent systems and controls, complex systems, supercomputing, mechatronics, and national defense issues is currently being done at top mechanical engineering departments around the world.

In order 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 university.

Currently, ME provides service to other majors by teaching a number of engineering fundamentals courses that include: ENGR 50 (Statics), ENGR 57 (Dynamics), ENGR 151 (Strength of Materials), ENGR 130 (Thermodynamics), ENGR 120 (Fluid Mechanics), and ENGR 135 (Heat Transfer). This year, ME will also be teaching ENGR 155 (Engineering Economic Analysis). This situation increases dramatically the teaching load of ME faculty.

Concerning graduate studies, the Mechanical Engineering and Applied Mechanics graduate group was approved in May of 2007. This multidisciplinary research group 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 variety of research topics, a number of graduate courses taught by MEAM faculty serve graduate students from different disciplines. This also increases the teaching load of ME faculty. For instance, the following courses, offered by ME faculty, have been taken by graduate students from MEAM and/or other programs: ES 235 (Heat Transfer), MEAM 201 (Advanced Dynamics), ME 210 (Linear Controls), and MEAM 251/ES 237 Viscous Flows.

There are currently three FTE positions filled in mechanical engineering, Professor Diaz, Professor Sun, and Professor Coimbra, denoted ME-1, ME-2, and ME-3, respectively. The excerpts of the CAPRA report to the EVC dated May 20, 2006 indicated "*two additional FTEs for ME are highly recommended, one at the senior Level.*" Out of these two recommended positions, only one was authorized as a result of the AY 2005-06 academic strategic plan, denoted ME-4 in Table 8. A senior faculty has been selected out of an outstanding pool of candidates and his case has been recently approved by CAP.

The memorandum date July 20, 2007 from Keith Alley authorized one additional FTE for ME, denoted ME-5. A search is already underway to fill out this position at the senior level in the area of complexity and energy systems. This position will expand the current areas of research available in the program, help with teaching courses at the undergraduate and graduate level, and help with the starting of the Energy Institute at UC Merced. One more Cross-Engineering FTE was authorized, denoted BIOE-7/ME-8, in the area of multi-scale modeling. The job description has already been posted on UCM website.

A total of seven desired positions have been identified and described below in descending level of priority for the major.

1. Bio control
2. Computational Engineering
3. Bio-Inspired Mechanics
4. Nonlinear Analysis
5. Energy (with emphasis in Fuel Cells or Hybrid Systems)
6. CFD
7. Mechatronics

The requested positions can be described as:

- ME-6: Senior/junior position complementing existing ME faculty
- ME-7: Senior/junior position complementing existing ME faculty

The program is also requesting ***two security-of-employment instructors***. One will concentrate on the engineering fundamentals courses and the other on ME electives.
The description of the requested FTE positions is as follows:

2.4.12 Mechanical Engineering: ME-6: Bio-Control

Mechanical Engineering sees a need for an FTE working on research in one or more areas of the emerging domain of Bio-Control. This senior/junior position will add an important and strategic area of research in ME to broaden and strengthen its actual capabilities. This position will cover, but will not be limited to, the design and construction of self-assembled structures, bio-mimetic surfaces, sensors and actuators that will allow external control of

biological and bio-technology systems. Mechanical Engineering and the MEAM Graduate Group see such a hire as necessary to position the campus competitively in this promising area of research. The undergraduate program in Mechanical Engineering will benefit with courses such as mechatronics (ME 142), vibration and controls (ME-140), and the capstone design (ME-170). The graduate program will benefit with courses in the particular areas of research of this FTE. Natural synergies with other programs include Bio-Engineering, Computer Science and Engineering, and Applied Mathematics. The space needs are expected to be adequate for a senior/junior level position in the wet lab area.

2.4.13 Mechanical Engineering: ME-7: Computational Engineering

This senior/junior position is an important and strategic area of research in ME and it is intended to strengthen the actual capabilities of ME faculty. It will cover, but will not be limited to, the development of numerical schemes to treat problems in structural, fluids, and/or thermal/fluids systems. It can relate to parallel computing and high performance algorithm development applied to engineering problems. The undergraduate program in Mechanical Engineering will benefit with courses such as FEA (ME 135) and CAE (ME 137). The graduate program will benefit with courses in the particular areas of research of this FTE. Natural synergies with other programs include Computer Science and Engineering, and Applied Mathematics. The space needs are expected to be adequate for a senior/junior level position in the dry lab area.

.

Table 8 School of Engineering Faculty 5-year Hiring Plan.

Academic Year	ENVE		CSE		BIOE		ME		MSE		EE		ChE		EEM		CE		Cumulaive Faculty FTEs
	Name	FTE	Name	FTE	Name	FTE	Name	FTE	Name	FTE	Name	FTE	Name	FTE	Name	FTE	Name	FTE	
	Bales	1.0	Newsam	1.0	Chin	1.0	Diaz	1.0	**Viney**	1.0	**Chiao**	0.5							
	Conklin	1.0	Kallmann	1.0	McCloskey	1.0	**Sun**	1.0	**Leppert**	1.0	**EE-2**	1.0							
	Harmon	1.0	Cerpa	1.0	Khine	1.0	Coimbra	1.0	Lu	1.0	**EE 3**	1.0							
	Winston	0.5	Carpin	1.0	**(Escobar)**	1.0	**ME-4 (Fried)**	1.0	MSE-4	1.0									
	Guo	1.0	Carreira	1.0	**BIOE-5**	1.0	**(Modest)**		(Davila)	1.0									
	Rogge	1.0	Oh	1.0	BIOE-6	1.0	lex Systems	1.0	**MSE 6**	1.0									
	Ervans(x)	*0.5*	Noelle	0.5	*Multi Scale*	0.5	*Multi Scale*	0.5											
	Westerling	0.5	CSE-8*	1.0	BIOE 8	1.0	*(TBD)*												
	Chen	0.5	**CSE-9***	1.0	BIOE 10	1.0	*(TBD)*												
	Sustain	1.0	CSE-10(x)	0.5	**BIOE 11**	1.0	ME 6	1.0											
	ENVE 11	1.0	***CSE 11***	**1.0**			ME 7	1.0											
	ENVE 12	1.0	**CSE 12**	**1.0**															
			CSE 13	1.0															
AY 05-06	5.5		6.0		4.0		2.0		2.0		0.5		0.0		0.0		0.0		20.0
AY 06-07	7.0		6.5		4.0		3.0		4.0		1.5		0.0		0.0		0.0		26.0
AY 07-08	7.0		7.5		5.0		4.0		4.0		1.5		0.0		0.0		0.0		29.0
AY 08-09	10.0		12.0		9.5		7.5		5.0		2.5								46.5
AY 09-10	12.0		15.0		12.5		9.5		6.0		3.5								58.5
AY 10-11																			0.0
AY 11-12																			0.0

Underlined (x) denotes cross-School hire - *Italics* denote cross-engineering hires - (Paranthetical) entries denote individuals under consideration - **Bold** denotes senior FTE

	Future FTE
FTE	**Current searches**

Table 9 Prioritized FTE Request List for AY2007-2008 SOE Strategic Plan

Priority	Name of Position	Level (Lecturer/Assistant/Associate/Full)	Primary Major Conribution (Current or Planned)	Secondary Major Contribution (Optional)	Primary Graduate Group	Secondary Graduate Group (Optional)	Estimated Start-up cost	Estimated Space Needs	Special needs and strategic considerations, if any
Critical	Bio-control	junior/senior	ME	BioE	MEAM	BEST	$ 500,000.00	750	Wet Lab
Critical	Computer Science	senior	CSE		EECS		$ 450,000.00	500	Dry Lab
Critical	Complex Material	senior	MSE	BioE	BEST	MEAM	$ 400,000.00	750	Dry Lab
Critical	Computational Eng	junior/senior	ME	CSE	MEAM	EECS	$ 550,000.00	500	Dry Lab
Critical	Tissue Eng	junior	BioE	MSE	BEST	QSB	$ 550,000.00	750	Wet lab
High	Environmental Microbiology	junior/senior	Enviorn Eng	BioE	ES	QSB	$ 450,000.00	500	Wet Lab
High	EE	senior	CSE	ME	EECS	MEAM	$ 450,000.00	500	Dry Lab
High	CS/EE position	senior	CSE	ME	EECS	MEAM	$ 450,000.00	500	Dry Lab
High	Bio-Inspired Mech	junior/senior	ME	MSE	MEAM	BEST	$ 550,000.00	750	Dry Lab
High	Physiological modeling	junior	BioE	ME	BEST	QSB	$ 550,000.00	400	Wet lab
High	Ecohydrology & Ecological Eng	junior/senior	Enviorn Eng	BioE	ES	BEST	$ 400,000.00	500	Wet Lab
Regular	Single cell measurement	senior	BioE	ME	BEST	QSB			
Regular	Media art	senior	CSE		EECS				cross-school
Potential Security of Employment Positions (SOE)									
1	CSE	potential SOE	CSE						
2	ME	potential SOE	ME						
3	ME	potential SOE	ME						
Management School Related Positions									
1	Natural Resource Management	senior							
2	Entrepreneurship	junior/senior			BEST				
3	Technology Management	senior							
4	energy, climatic & sustainability	junior/senior							
5	biotech Management	junior/senior			BEST				

2.4.14 Cross-School Hire

Last year, SOE proposed several cross-school positions. Some of these positions were endorsed by CAPRA and recommended as cross-school positions. However, SOE did not receive some of these FTE allocations from the Provost. The faculty of SOE was not able to identify the rationale for these irregularities. Without a transparent policy for cross-school FTE allocations, SOE faculty has decided to request only one cross-school FTEs this year.

3 Strategic Planning Framework

Section 2 of this plan began with a justification for the request for 13.5 faculty FTEs to be hired into the School of Engineering during the AY 2008-09 academic year, bringing our total faculty to 42.5 Engineering faculty FTEs as shown in Table 6. The discussion then shifted to the impact that this increment in faculty resource would have on the further development of our academic programs, and most importantly, to a listing of the specific faculty FTEs by research area and cross-School synergies that would result—presented in Section 2.4. Similarly, Section 2.5 presented a list of 2 Cross-Engineering hires that would further enhance the programs of the School of Engineering, but more important, would further provide opportunities for strategic multidisciplinary research opportunities across UC Merced. To the extent possible, these proposed positions have been discussed to various degrees, with our colleagues in our sister schools.

3.1 Revisiting the Strategic Faculty Hiring Framework

The strategic value of the faculty hires proposed in Section 2—both intra-School and cross-Schools hires—are presented in Table 10, which is an expanded and updated version of the hiring framework proposed last year. The columns of Table 10 represent the emphasis areas within Engineering sub-disciplines being developed at UC Merced, with each column corresponding to a strategic research opportunity shaping specific faculty hires; present, current, and future. The rows of Table 10 list more comprehensive cross-Schools research areas that have been discussed, and than have emerged as a result of the faculty hiring process over the years. These columns are deliberate in their inclusion of priority cross-School strategic research areas, but are themselves grouped within the six priority research areas set forth in Section 1: (1) Energy and Materials Technologies, (2) Biological Engineering, (3) Nanoscale Systems, (4) Environmental Science and Engineering, and (5) Computational Science and Engineering, and (6) Modeling Sciences.

3.1.1 Energy and Materials Technologies

The early energy emphasis at UC Merced focuses on solar energy. Both **optics and materials** play a key role. The use of advanced optics techniques, and nonimaging optics in particular enable the generation of high temperature for power and heat, as well as efficient photovoltaic power through concentration. Advanced materials are critical across all solar energy technology. These areas of optical design and material science span a range of disciplines from applied mathematics (optical design) to condensed matter physics (photovoltaic materials) to engineering (thermal and electrical components and systems).

Mechanical and electromechanical systems are integral to virtually any kind of engineering system, with rapid growth now being observed at the micro and nano levels. Examples of such systems include transportation systems, energy production and control systems, environmental management systems, and an increasingly important area of bioengineered systems. Not only will it be essential for the School of Engineering to have a very strong research and education foundation in these key engineering areas, but this foundation will also be invaluable for the cross-disciplinary framework that we seek to establish across our university. As we develop a program in medical research and technological development, bio and electro-mechanical research innovation will be extremely important.

Table 10 Revised strategic cross-School hiring strategy for AY 2007-08 from the School of Engineering.

Strategic Faculty Hiring Planning Matrix--This matrix is intended as a framework for displaying the structure of faculty hiring within the School of Enigneering at UC Merced. The left column presents the strategic research priorities within Engineerring. Each area is further categorized by potential cross-School priority areas. The columns to the right reflect research emphasis areas grouped by disciplinary categories, also reflecting our current and future undergraduate majors. Entries in the table correspond to current, pending, and desired future faculty hires.

Current and Planned Undergraduate Majors witin the School of Engineering

Strategic Research Priorities within the School of Engineering	Strategic Cross-School Research Opportunities	ENVE						CSE					BIOE					ME					MSE						EE							
		Hydrology	Microbiology	Water Quality	Air Pollution	Environmental Sustainability	Energy water & resource management	Networking	Data Base Mining/Informatics	Robotics/Autonomous Agents/AI	Graphics/Multimedia	Architecture/Systems	Bioelectronics	Biomaterials Engineering	Cellular Bioengineering	Tissue Bioengineering	Bioprocess Eng	Energy and Environment	Computational Mechanics	Complex and Intelligent Systems	Multiscale Phycics and Modeling	Bioengineering	Nanomaterials	Composite materials	Materials Synthesis	Materials characterization	Environmental Aspects Materials	Materials Processing	Microelectronics and Nano Technology	Communication Networks	Bioelectronics	Optics and Photonics	MicroElectroMechanical Systems	Signal Processing	Circuits	Linear/Nonlinear Systems, Control
Energy and Materials Technologies	Energy; including optics, material sciences					☒																	☒														
	Mechanical and electromechanical systems												▢		▢		☒			▢					☒							☒					
Biological Engineering	Human biology, health and enviroment, including management and policy														☒					▢																	
	Regenerative medicine													▢		☒																					
Nanoscale Systems	Nanotechnology												☒			▢								▢		☒		▢									
	Human dimesions of engineering and science																										▢										
Environmental Science and Engineering	Atmospheric & climate sciences, air resources			☒	☒		▢																														
	Energy, Water & Environmental sustainability, including policy	☒		☒		▢	☒																														
	Remediation		▢																																		
	Ecological Engineering	▢																																			
	Geography and spatial analysis and global change						☒	☒	☒			▢																									
Computational Science and Engineering	Cognitive and computational sciences								☒	▢	☒																										
	Media arts and Technology										▢																										
	Cyberinfrastructure and system							☒	▢	☒	▢	▢							▢															▢			
Modeling Sciences	Management and decision sciences					▢	☒																														
	Mathematical sciences, applied mathematics, and applied statistics								☒						▢		▢	☒	▢	☒	▢	☒															
		10						12					9.5					8					6						2.5							

- Engineering faculty (first 20)
- ☒ Engineering faculty already hired
- ▢ Joint (cross-school) faculty hires or joint hires requested
- ▢ Joint (cross-engineering) faculty hires or joint hires requested
- ▢ Current faculty searches
- ▢ To be requested; need to be distributed into the matrix

3.1.2 Biological Engineering

Human biology, health and environment—including management and policy focuses on improving human health through an understanding of physical, chemical and biological processes, interpreted through the design-based and problem-solving skill set of engineering. The influences of physical and social environment on health, and strategies for influencing these environments positively, are included. Objectives include significant health-care cost reduction, development of methods for earlier and more accurate diagnosis, possible therapeutic interventions, and effective preventive measures for patients at high risk.

Regenerative medicine refers to technologies that repair or replace diseased, damaged or defective tissues or organs. This focus area represents an emerging multidisciplinary field involving biology, medicine, chemistry, physics, materials engineering and bioengineering. It is expected to revolutionize the current therapeutic measures by restoring tissue and organ function that are affected by the natural aging process or diseases.

3.1.3 Nanoscale Systems

At nanometer length scales, the physical and chemical properties of matter are dictated by quantum phenomena. **Nanotechnology** aims to exploit these material properties directly, as well as in the context of novel machines and electronic devices that operate on a very small scale, comparable to or smaller than the scale of functional devices found in nature. Also included, is the design and exploitation of self-assembling molecular systems and nanoscale devices to produce macroscopic objects with precisely controlled specifications. The effects of nanoparticles on human health and the environment will require careful, extensive attention.

The **human and ethical dimensions of science and engineering innovation** will be increasingly important in the future for new areas of social concerns such as bioengineered systems, environmental and energy systems, and virtually all biomedical and medical technology areas.

3.1.4 Environmental Science and Engineering

This strategic research priority builds on existing faculty strengths to gain a competitive edge in the areas of (1) **atmospheric sciences, climatology and air resources**, (2) e**nergy, water, and environmental sustainability**, and (3) **geospatial analysis and global change.** Research opportunities associated with this research priority are abundant from both a regional and global perspective. Specific research topics for the first area may encompass air pollution chemistry, air quality characterization and management, and other topics critical to human and environmental health. The second area encompasses the science, technology and management of these resources that are critical to global economy and life itself. The third area encompasses the analysis of large spatial data sets, such as those generated through remote sensing technologies, to observe changes in land use, vegetative canopy and other environmental properties in response to drivers such as climate change.

3.1.5 Computer Science and Engineering

Cognitive science and engineering is the interdisciplinary study of mind and intelligence, embracing philosophy, psychology, artificial intelligence, neuroscience, linguistics, and anthropology. Cognitive and Computation Sciences refers to all the computational aspects of

these domains and ultimately aims to create computer models and algorithms able to reproduce intelligent behavior in intelligent systems. Example of covered domains include: image processing, computer vision, artificial intelligence, statistical and machine learning, neural networks, computational neuroscience, nonlinear dynamics, nonlinear control theory, robotics, behavioral animation, virtual reality, human-computer interaction, etc.

Media Arts and Technology (MAT) is an interdisciplinary area that fuses emergent computer science and engineering, and digital art research, practice, production, and theory. MAT offers the opportunity for working at the frontiers of art, science, and technology, where new art forms are born and new expressive media are invented. The highly cross-disciplinary nature of this exciting field, and the direction being taken at UC Merced with key faculty hires within the School of Engineering and the School of Hunamities, Social Sciences, and Arts, suggest that this is an excellent opportunity for innovation at UC Merced.

Recent trends suggest that inexpensive networked video sensing elements will be pervasively deployed in our environment. Already, they are embedded in devices such as computers and mobile phones and they are mounted in public spaces such as malls and airports. In many ways, this trend could prove beneficial to society, in that information collected by sensors could be shared for the better good. Harnessing the power of these emergent sensory environments will hinge on our ability to build applications capable of gathering, interpreting and storing data from distributed sensors and to provide scalable mechanisms for managing the networks and systems resources that these applications consume. We anticipate the design, implementation, and testing of a state-of-the-art signature facility for this purposes—the UC Merced Sensorium.

The UC Merced Sensorium would catalyze fundamental advances in image and video computing, network protocols, and resource management to deal with unique spatio-temporal constraints of sensor networks in general and of video sensor networks in particular. It will also contain hardware and software for image, audio, and video capture and processing; motion capture; visualization; interactive display; digital preservation; and innovative internet interaction. When fully developed, the Sensorium educational and research infrastructure will be composed of a sensor network of video cameras spanning several areas, networked processing units, and a terabyte database, managed together to satisfy queries using those generated by mobile users within this environment. It will support a number of undergraduate and graduate courses, including

- Multimedia Systems (undergraduate)
- Arts and Technology (undergraduate)
- Computer Networks (undergraduate)
- Operating Systems (undergraduate)
- Digital Image Processing (undergraduate)
- Digital Audio Processing (undergraduate)
- Digital Video Processing (undergraduate)
- Databases (undergraduate)
- Computer Vision (undergraduate)
- Computer Graphics (undergraduate)
- Programming Languages (undergraduate)
- Embedded Systems (undergraduate)
- Real Time Systems (graduate)

- Advanced Computer Networks (graduate)
- Sensor Networks (graduate)
- Distributed Systems (graduate)
- Computer Animation and Simulation (graduate)
- Advanced Digital Image Processing (graduate)
- Advanced Computer Vision (graduate)
- Advanced Databases (graduate)
- Data Mining (graduate)
- Motion Planning and Cognition (graduate)
- Security and Privacy (graduate)
- Visualization (graduate)

The Sensorium will serve a variety of constituents including faculty in computer science, electrical engineering, art and cognitive science. It will be a core facility for the proposed interdisciplinary program in Multimedia Arts and Technology. Through hosting classes, seminars, and performances, it may also provide opportunities for synergies between the campus and local community.

The term "**cyberinfrastructure**" was coined by a National Science Foundation (NSF) blue-ribbon committee. In general, the term refers to systems that facilitates the development of new applications, allows applications to interoperate across institutions and disciplines, insures that data and software acquired at great expense are preserved and easily available and empowers enhanced collaboration over distance, time and disciplines. It also includes effective management of distributed resources (data and facilities). Some other names in use for such systems are co-laboratory, grid community/network, virtual science community and e-science community.

3.1.6 Modeling Sciences

Modeling sciences refers to the broad array of disciplines used throughout math and science disciplines, including **mathematical modeling** and **operations research**, **applied mathematics and statistics**, **decision sciences**, and **quantitative analysis and reasoning**. From the initial discussions of building at UC Merced a culture of multidisciplinary research and education, there has been considerable interest in establishing a broad foundation of modeling and modeling technologies as a framework for this synergy across the current and future Schools. This framework would encompass and promote strong synergy among a broad spectrum of academic disciplines, including simulation modeling, optimization modeling, statistical and inferential modeling, and perhaps physical modeling. It was argued early on in our development that an emphasis on modeling and modeling technologies could be valuable at all levels and across virtually all domains. Even our initial discussions about general education considered a strong component of modeling as a means to improve personal decision makinge and proeuctivity. Indeed, the *Decision-making* guiding principle of General Education at UC Merced was an artifact of that early discussion.

While the emphasis on this as an area of synergy between and among Schools has not remained central in discussions of cross-Schools priorities, it remains a priority within the School of Engineering, and will very likely re-emerge as a top priority because of the successful development of programs across Schools, including Cognitive Science, Economics, and Management within the School of Social Sciences, Humanities, and Arts; Quantitative Biology and Ecology within the School of Natural Sciences, and virtually all

disciplines within the School of Engineering. This is an ideal focus area for attracting cross-School multidisciplinary faculty hires, and while it will certainly remain a cross-cutting area for research and scholarship—rather than an area "owned" predominantly by one School—it is very consistent with the foundational vision behind UC Merced.

3.2 Strategic Faculty Hiring

The entries in Table 10 each correspond to a faculty FTE, either one already filled, one currently being recruited, or one being proposed within this strategic plan. Blue cells in the table correspond to the initial allocation of 20 faculty for the school of Engineering—those blue cells marked with X indicate positions already filled. Cells shaded yellow ☐ indicate positions that have been authorized for recruitment currently in process. Cross-School hires are denoted by cells having a bold border ☐ regardless of color, while cross-Engineering hires are denoted by cells having a double border regardless of color, either current faculty or anticipated hires. And cells shaded orange ☐ denote FTEs requested for AY 2007-2008.

The table thus reflects, for each faculty hire or potential faculty hire, the synergies that will result within and among Engineering disciplines, as well as between and among Schools having shared strategic research areas.

4 Space Planning and Management

4.1 Space Challenges at UC Merced

The growth of academic programs within the School of Engineering at UC Merced depends in part on the availability of space in the form of research facilities, faculty, student, and "professionals" office space; teaching labs; essential support facilities such as conference and meeting rooms; and other support space such as administrative offices and other space for scholarly activities. The space in the Science and Engineering Building is of course finite, and the second Science and Engineering Building (SE2) will not be available for the space inventory until fall of 2012. Table 2 suggests that with 20% of the student body—which will number approximately 4558 at that time—and faculty FTEs based on student numbers and student faculty ratios, the size of the Engineering faculty may be expected to be about 51 FTE at the beginning of AY 2012-13. Assuming that the School of Natural Sciences will comprise conservatively 30% of the student body[vi], and with similar assumptions about faculty numbers, NS could have as many as 70 faculty by the time SE2 is available. This means that at the time SE2 comes on line, the total faculty FTE within the combined Schools of Natural Sciences and Engineering may be as high as 121, or more than 40 - 50 FTE more than the total office space available in SE1based on the original campus planning space numbers. With the size of SE2 already set at less than 52,000 ft^2 assignable, it may be more than half full upon opening.[vii] As the original per-faculty space numbers used in planning SE1 failed to provide office space for research groups (e.g. grad students and post docs), the true demand for SE1 and SE2 space is much higher. From another perspective, this level of growth may mean that SE1 reaches capacity by 2008; four years before SE2 comes on line.

As a result, it will be imperative that space at the Castle facility be used efficiently and effectively in support of campus space needs. Future space planning and management for SE1 should be aligned with campus space planning objectives.

4.2 Space Allocation, Utilization Monitoring, and Reallocation

The School of Engineering currently occupies space in the Science and Engineering Building (SE1). In the discussion below, *allotment* refers to the designation of specific space for management and use by the School of Engineering, and *assignment* refers to the designation of space by the Dean of Engineering to individual faculty, programs, projects, etc.

4.2.1 Initial campus space allotment

The initial allotment of space by the Provost to the School of Engineering consisted of:

1. The use of 25 faculty offices;
2. A total of 32.4% of research space to support the inaugural faculty; and
3. The Deans suite of offices on the second floor of SE2.

The initial allocation of space to the School of Natural Sciences was identical, and the total area was divided up between the two schools. This initial allocation was thus intended to house the first 40 faculty, with the initial 5 faculty offices made available to each school to support other space needs with the understanding that when the building is "full," all faculty offices will be occupied by faculty only. The 5-office "buffer" controlled by each school will be correspondingly reduced to zero as the building reaches capacity.

Beyond the initial allotment of space in SE1 for faculty offices and research space, the Deans of both Schools have agreed on an additional allotment for housing all faculty and their anticipated research activities up through those faculty expected to be hired by fall 2007. This second and third rounds of allotment divided all faculty offices and research space between the two schools resulting in 33 faculty offices and 21,535 sq. ft. of research space allocated to the School of Engineering.

Following the final allocation of space, the School of Engineering is short in 6 offices and research space for 6 junior and 2 senior authorized FTEs, space will have to be assigned at Castle.

4.2.2 Initial engineering research space allocation

The allocation of space allotted to the School of Engineering has been (is being) made by the Dean of Engineering as follows:

1. Each faculty member has been assigned a standard faculty office in general proximity to their assigned lab space, and to other faculty within the School of Engineering and the School of Natural Sciences having similar or related research programs.
2. Four groups of faculty were initially identified based on disciplinary areas of research and teaching responsibilities, and corresponding research space areas were identified by the Dean and designated for ach group. The groups developed recommendations for the specific allocation of each area among members of the group, as well as common areas to be shared within the group--which may also include faculty members from outside the group. Initial faculty research space assignments were based on these recommendations.
3. Requests for use of buffer office space was considered by the Dean following issuance of priorities for the use of that space, and temporary office space assignments were made.
4. Office and research space needs for future faculty will be assigned by the Dean until all faculty offices are assigned (NOTE: at this time SE1 will have insufficient space for postdocs, instructors, lecturers, and other research staff.)

Table 11—Space assignment factors.

	PROPOSED FORMULAS		
	Research (ft^2)	PD office (75 ft^2/FTE)	GS Office (50ft^2/FTE)
Assistant	250	0.5	3
Associate	500	0.75	6
Full	750	1	9

Specific faculty space allocations were made using the general guidelines reflected by the factors contained in Table 11. For example, associate professors in the School of Engineering will be assigned an ***average***[viii] of 500 ft^2 of lab space, with an additional allocation of space for post doctoral researchers of 75 ft^2 per person, and 50 ft^2 per graduate student. It is assumed that as our program grows, associate professors will have an average of .75 post doctoral scholars per person, and an average of 6 graduate students including both Masters and Ph.D. students. Similarly, faculty at the rank of full professor will be provided an average of 750 ft2 of lab space, and additional space for an average of 1 postdoctoral associate, and 9 graduate students.

The research space allocation factors were obtained from the initial planning documents for the Science and Engineering building, and the researcher (post doc and grad student) space factors were obtained from the CPEC guidelines. While it can be argued that these space

allotments are less than what might be available anecdotally at other UC campuses, the averages will likely include faculty who have very modest or no lab space allocations.

NOTE: These estimates do not include space allocations for shared core research facilities.

The estimates for the average numbers of post doctoral scholars and graduate students anticipated for School of Engineering faculty as shown in Table 13 were estimated from numbers obtained from several UC Engineering Schools as presented in Table 12. While these data were not yet obtainable for all campuses, nor broken down by faculty rank—we will be pursuing this more detailed breakdown of data in the future—they show that the factors proposed in Table 11 are generally realistic and defensible. For example UC Davis, with a total of 176 regular faculty FTE reports 80 postdocs, or approximately 0.5 postdoc per faculty member (averaged across all ranks). These data suggest that our estimates for the numbers of graduate students at UC Merced may be a bit high in comparison with other campuses, but not excessively so, and may be modified after we receive complete data from all sister campuses.

Table 12 Reported numbers of graduate students, and other academic personnel in UC Engineering Schools.

Campus	Faculty	Graduate Students[1]				Other Academic Personnel[2]					
		Masters		Doctoral		Post Docs		Instructors		Researchers	
	Count	Count	Fac Avg	Count	Fac Avg	Count	Fac Avg	Count	Fac Avg	Count	Fac Avg
Santa Cruz	66	81	1.2	193	2.9						
Santa Barbara	125	110	0.9	584	4.7						
San Diego	166	346	2.1	801	4.8						
Riverside	73	53	0.7	238	3.3	24.0	0.3	14.0	0.2	14.0	0.2
Merced	14	9	0.6	8	0.6						
Los Angeles	150	474	3.2	782	5.2						
Irvine	154	59	0.4	249	1.6	58.0	0.4	10.0	0.1		
Davis	176	334	1.9	782	4.4	80.0	0.5	20.0	0.1	16.0	0.1
Berkeley	218	235	1.1	1354	6.2			45.0	0.2		
Total	1163	1880	1.6	5448	4.7						

[1] Report to the University Wide Council on Engineering Education UCEE Fall, 2005
[2] Direct consultation with Schools

The anticipated need for additional space prior to the availability of the second Science and Engineering (SE2) building becomes evident when considering that (1) the total available space in SE1 totals slightly more than 100,000 ft^2, (2) the School of Science—having space requirements similar to those of Engineering—is likely to be on the order of 20% larger than Engineering in terms of students and faculty, and (3) this does not include the entire 1st floor of SE1, which is exclusively allocated for teaching labs: approximately 1/3 of the total assignable square footage.

Table 13 – Space Needs Planning.

Name	Offices on campus (number)	Labs Space on Campus (sq. ft.)	Total campus Space	Space at Castle (sq. ft.)	Space at other location
Current total (7/2007)	33	21,535	21535	0	0
	New FTSs space needs				
	Faculty Offices	Research Space (sq. ft.)	Sitting stations Graduate Students	Sitting stations Post Docs	Instructors offices
New space for AY08-09 hires	11	6650	28	17	3
Total for AY08-09	11	6650	28	17	3

[1] **SoE is short I 6 offices for the current authorized FTEs and research space for 6 junior and 2 senior authorized FTEs**

It should be emphasized that the estimates presented in Table 13 do not consider adequately the CPEC guidelines. Not only did the original planning for SE1 fail to account properly for the resulting size of graduate research groups, but they also failed to account for the resulting number of instructors, and other multidisciplinary research infrastructure. Using the same projections for faculty recruitment and size of graduate research groups, the use of CPEC factors would result in a much greater space requirement as reflected in Table 13. It is important for future planning activities that realistic assumptions be used during the request for, and justification of, new space.

4.2.3 Core research facilities

In any consideration of research space allocation, it is vitally important to plan for the presence of shared research core facilities on campus. Not only do these facilities contribute to the research missions of multiple faculty (typically 10-20), but they are also actively utilized in teaching and need to be placed on campus so that graduate and undergraduate students have the benefit of training on commonly-used instrumentation. This integration of teaching and research makes efficient use of space, and is pedagogically desirable and strongly encouraged by the National Science Foundation, as evidenced by the over $1M in grants received by UC Merced faculty to develop two core facilities, the Environmental Analytical Facility and Imaging and Microscopy Facility. Core facilities are generally operated on a recharge basis in order to minimize cost to the university, and for them to generate the income necessary for operation they must be on campus where they will be utilized by researchers and for teaching. Sufficient space allocation for core facilities is essential to the development of UC Merced as a research university.

4.2.4 Teaching laboratory space allotment

Recommendations for the allotment of space for teaching in the SE1 will be made to the deans of both schools by a newly formed teaching laboratory planning committee. This committee will be lead by the assistant deans of both schools, with participation from lab managers from both schools, Steve Rabedeaux, Nancy Tanaka, and, as appropriate, from the Office of the Registrar.

4.2.5 Space utilization monitoring and reallocation planning

Monitoring and assessment of the use of assigned space will be the responsibility of the office of the dean of the School of Engineering, working closely with the newly formed SoE Academic Resources Committee. Assignments of additional space to individual faculty, groups, projects, etc. will be made following careful justification and consideration. Similarly, reduction in space allocations will be made as appropriate such that the space resource serves the best interest of the School and the university.

ENDNOTES

[i] The original target was 1,000 student FTEs upon opening, which was not achieved. The actual student FTE of 875 students (total undergraduate and graduate students) is reported in Table 1.

[ii] The 10-year planning horizon was selected in part because this represents the time over which the second phase of campus construction—specifically, the second Science and Engineering building—will be complete and [probably] fully occupied. This should represent a time in the future at which a reasonably steady-state rate of student recruiting and faculty hiring will be achieved, and in particular, the time after which few if any additional undergraduate majors are likely to be added to the program.

[iii] STEM stands for Science, Technology, Engineering, and Math, and is increasing used to describe institutions of learning that emphasize these technical areas as a major mechanism for increasing participation of women and minorities in professional technical areas.

[iv] E. A. Lee and D. G. Messerschmitt, "Engineering an Education for the Future," *IEEE Computer Magazine*, Vol. 31, No. 1, January 1998, pp. 77—85.

[v] See, for example E. A. Lee and P Varaiya, "Introducing Signals and Systems—The Berkeley Approach," *The First IEEE Signal Processing Education Workshop*, Hunt, Texas, October 15-18, 2000. or E. A. Lee, "Designing a Relevant Lab for Introductory Signals and Systems," *The First IEEE Signal Processing Education Workshop*, Hunt, Texas, October 15-18, 2000.

[vi] Some estimates suggest that this number may be closer to 40% of the student body at UCM.

[vii] This depends, of course, on the space required for research labs and auxiliary uses. Planning will soon begin pursuant to the PPG for SE2, which should be complete by late spring 2006.

[viii] While actual assignments will of course depend on individual research programs, it is expected that these will represent an average over all faculty, at least until we get better projects/information.

STRATEGIC PLAN

School of Natural Sciences

AY 2007-2012

(2008 update)

January 29th, 2008

TABLE OF CONTENTS

A. SNAPSHOT OF THE SCHOOL OF NATURAL SCIENCES.....1

B. FACULTY AY 2007-2008.....2

C. INTRODUCTION.....3
Vision and Mission 3
Values 4
Goals 5
Special Opportunities and Challenges 5

D. SUMMARY OF FIVE YEAR PROGRAMATIC GROWTH PLAN.....7

E. PROGRAMMATIC RESEARCH AREAS AND TEACHING 8
Applied Mathematical Sciences.....8
Biomedical/Biological Sciences 12
Chemistry 19
Environmental Sciences, Integrative and Evolutionary Biology, and Environmental Health Sciences 26
Physics 37

F. ACADEMIC PROGRAMS.....44
Undergraduate Programs 45
Applied Mathematical Sciences.....46
Chemical Sciences 47
Earth Systems Science 47
Biological Sciences.....48
Physics 48
Minors.....49
Metrics for Success of Undergraduate Programs and Majors 49

Graduate Programs.....49
Applied Mathematics.....50
Chemistry and Physics.....51
Environmental Systems 52
Quantitative and Systems Biology 53

G. INITIATIVES 54
Biomedical Sciences Research Institute 54
Planning for Medical Education at UC Merced.....54
Science-Math Initiative (SMI): California Teach 55
Student Academic Success 57
Science and Math Education Center 58

H. SPACE AND FACILITIES.....59

I. PUBLIC SERVICE.....61
Research.....61
Teaching.....61
Community Partnerships.....61

J. METRICS OF SUCCESS FOR RESEARCH AND ACADEMIC PROGRAMS.....62
Overall Metrics.....62
Faculty Mentoring.....63

APPENDICES
Appendix 1: Comparative Data, Faculty Workload, Majors, Enrollments and Projections

A. SNAPSHOT OF THE SCHOOL OF NATURAL SCIENCES

Table A1: Faculty, Students, Space

Resources	2005-06 Actual	2007-08	2010-11 *Projected*[c]
Faculty Positions (total)[a]	27	39	77
Lecturer FTE	2	5.5	7
Undergraduate Majors[b]	312	594	1,348
Graduate Students (in graduate groups, shared across schools)	26	45	180
Space (assignable square feet)	24,200	~38,000	70,000

[a] Filled and unfilled positions allocated to Natural Sciences
[b] Undeclared and declared majors and undeclared students in Natural Sciences
[c] Faculty projections

Table A2: Student Enrollments in Natural Science Courses

Course Enrollments	AY 2005-2006[a]	AY 2006-2007[b]	AY 2007-2008 *Projected*[c]
Mathematics	925	1,230	1,962
Physics	344	510	569
Biology	510	860	1,758
General Ed	274	255	65
Chemistry	462	855	1,235
ESS	28	74	116
NSED			195
Total (% campus enrollments)	2,543 (34%)	3,784 (42%)	5,900 (43%)

[a] Actual enrollments at the 3rd week in Fall 2005 and Spring 2006
[b] Actual enrollments at the 3rd week Fall 2006 and Spring 2007
[c] Actual enrollments Fall 2007 and projected at the 3rd week Spring 2008

B. FACULTY AY 2007-2008

Andres Aguilar, Assistant Professor
Keith Alley, Professor, EVC/Provost
David Ardell, Assistant Professor
Miriam Barlow, Assistant Professor
Francois Blanchette, Assistant Professor
Raymond Chiao, Professor
Jinah Choi, Assistant Professor
Michael Cleary, Assistant Professor
Michael Colvin, Professor
Michael Dawson, Assistant Professor
Benoit Dayrat, Assistant Professor
Phillip Duffy, Adjunct Associate Professor
Henry Forman, Professor
Carolin Frank, Assistant Professor
Marcos Garcia-Ojeda, Assistant Professor
Sayantani Ghosh, Assistant Professor
Ajay Gopinathan, Assistant Professor
Boaz Ilan, Assistant Professor
Anne Kelley, Professor
David Kelley, Professor
Arnold Kim, Associate Professor
Lara Kueppers, Assistant Professor
Andy LiWang, Associate Professor
Patti LiWang, Professor
Jennifer Manilay, Assistant Professor
Monica Medina, Assistant Professor
Matthew Meyer, Assistant Professor
Kevin Mitchell, Assistant Professor
Alexsandr Noy, Adj Associate Professor
Rudy Ortiz, Assistant Professor
David Ojcius, Professor
Peggy O'Day, Professor
Maria Pallavicini, Professor, Dean
Jason Raymond, Assistant Professor
Jay Sharping, Assistant Professor
Michael Sprague, Assistant Professor
Samuel Traina, Professor, Vice Chancellor Research/Graduate Dean
Meng Ling Tsao, Assistant Professor
Mayya Tokman, Assistant Professor
Anthony van Buuren, Adjunct Associate Professor
Wil Van Breugel, Adjunct Professor
Roland Winston, Professor
Tao Ye, Assistant Professor

C. INTRODUCTION

VISION AND MISSION

The University of California has a tripartite mission of research, teaching and public service. Research excellence forms the foundation upon which academic programs flourish in all of the campuses of the University of California system. Research excellence translates to excellence in graduate education and undergraduate experiences. The School of Natural Sciences is developing stellar academic programs for discoveries and applications in science and technology and for graduate and under-graduate education. The research and teaching programs will serve as an economic engine for the region and the state of California and contribute to development of a college-going culture in the San Joaquin Valley.

The vision of the School of Natural Sciences is to develop multidisciplinary and inter-disciplinary research programs and innovative undergraduate and graduate curricula, to distinguish itself among established science programs, to provide the best possible preparation for its students as they address the many scientific challenges of the 21st century, and to address the needs of its stakeholders in the region and the state of California.

- ***Multidisciplinary and inter-disciplinary research programs***

  The programs in the School of Natural Sciences are thematically categorized into Applied Mathematical Sciences, Environmental and Evolutionary Sciences, Health and the Environment, Biomedical Sciences, Biological Chemistry and Physics, Atomic, Molecular and Optical Physics and Condensed Matter Physics and Chemistry. Thematic groupings emphasize the commitment of the faculty and School administration to research programs that encourage cooperation and collaboration across disciplines. Thematic groupings acknowledge that finding solutions to complex problems often requires multi-disciplinary expertise and the growth of research programs should not be hampered by disciplinary boundaries.

- ***Innovative undergraduate and graduate curricula***

  Curricular innovations in degree programs and foundational courses for science and engineering students are highly valued by the School. The faculty and school administration are committed to innovative pedagogies that increase the recruitment and retention of students in mathematics, the sciences and engineering. The faculty of the School of Natural Sciences has the wonderful opportunity to create and shape curricular programs and offerings to provide both the scientific breadth and the depth required for graduates in the 21rst century.

- ***Provide the best possible preparation for its students as they address the many scientific challenges of the 21st century***

  UC Merced has the most ethnically and culturally diverse student body amongst the UC campuses. In AY 2006-2008, more than 40% of the students on campus declared majors in the School of Natural Sciences, providing enormous opportunities to

develop a diverse workforce with a strong science and mathematics preparation. An appreciation and commitment to diversity at all levels (students, staff and faculty) in the School and across multiple activities are essential for success of our students, the School of Natural Sciences and UC Merced.

- ***Contribute to addressing the needs of stakeholders and constituents in the San Joaquin Valley and the state of California***

The School of Natural Sciences recognizes its responsibility and value to the public and is committed to addressing the needs of its stakeholders in the State and in the San Joaquin Valley region. The San Joaquin Valley has been underserved in access to higher education and in reaping the economic and intellectual benefits of a research university. Graduates of degree programs in mathematics and sciences will be well-prepared to contribute to solving complex problems that face our region, state, nation and the world. Access is the key to personal success in modern society and an important goal is opening doors to higher education to groups that have not traditionally had opportunities in higher education. The research programs of faculty in the School of Natural Sciences have far reaching implications to advance the health and well-being of humans and the environment, while making fundamental discoveries about the world in which we all live.

VALUES

Excellence in Scholarship

A top priority of the School of Natural Sciences is scientific excellence. Programs of scientific excellence form the foundation for continued success in recruiting the best faculty, encouraging students, and providing multiple pathways to improve higher education and economic opportunities. The School recognizes the value of disciplinary depth, as well as interdisciplinary and multidisciplinary academics and research.

Academic excellence in training scientists and citizens

The School of Natural Sciences places a high priority on increasing the scientific literacy of all students and increasing the pool of students in UC Merced's academic programs in math, science and engineering. There is an increasing need for well-trained scientists, for scientifically trained decision makers and for a scientifically literate public to meet the global and technological challenges of the 21st century. Academic programs that encourage recruitment and retention of students into math and sciences, while maintaining the highest academic standards are a high priority. Innovative curricula and commitment to teaching excellence in Natural Science courses are essential for student success.

Recognition of the special responsibilities incumbent on a new school of sciences

The School of Natural Sciences recognizes that as the first new school of sciences in the 21st century it has a special responsibility to be innovative in its research, teaching and relationships with its partners and communities. The School is committed to developing unique multi- and inter-disciplinary research and academic programs and recognizes that

partnerships with higher educational institutions and communities leverage resources across the region, state and nation, enabling new synergies and promoting progress.

GOALS

The overall goal of the recommendations described in this strategic plan for the School of Natural Sciences is the development of outstanding research and academic programs, spanning the full range of scientific disciplines. Achieving this goal is dependent on success in a number of more specific objectives including intertwined objectives are:

- Success of junior faculty in establishing excellent research programs -- requires sufficient space and facilities, a pool of high-quality graduate students, reasonable teaching loads, and effective mentoring.
- Continued recruitment of excellent faculty -- requires sufficient space and facilities, competitive start-up packages, reasonable teaching loads and strong graduate programs.
- Recruitment and retention of top quality graduate students -- requires strong research programs, sufficient faculty to form effective graduate groups, and a diversity of graduate courses.
- Successful implementation of a broad range of innovative undergraduate programs in science and mathematics that attracts and graduates excellent students – requires sufficient faculty to teach a breadth of subject matter, reasonable class sizes, an adequate number of qualified teaching assistants, and access to undergraduate research opportunities.
- Continued commitment to diversity among faculty and staff to opening doors to higher education for all students, including those that traditionally have not had opportunities in science and math careers.

SPECIAL OPPORTUNITIES AND CHALLENGES

A new university faces many challenges, but also has numerous advantages compared to established universities. The ability of the School of Natural Sciences to leverage opportunities is essential for our success in rapidly building world-class research and academic programs. These opportunities include:

- ***Lack of disciplinary barriers:*** At established campuses, the departmental organization imposes serious barriers to developing multidisciplinary research and academic programs. These barriers are evident in the hiring and promotion of faculty who do not fit into traditional academic categories and in space commitments for inter-disciplinary projects. These barriers limit development of programs that link multiple disciplines to address complex problems. The absence of barriers at UC Merced allows facilitates cross-school graduate groups and multidisciplinary research programs.

- ***Long-term sustained faculty growth:*** The small number of faculty spread across many disciplines in the School of Natural Sciences is one of our most conspicuous

opportunities and challenges as a new program. Even with modest growth projections, workload and unique opportunities will continue to bring 6-8 new faculty lines to the School each year, offering ongoing opportunities to build new research programs. This capability is much more constrained in existing campuses, where faculty lines are usually distributed into narrow discipline-based departments and are not available for building strategically in new research areas.

- ***New research facilities:*** The Science and Engineering Building at UC Merced is home to science and engineering faculty in all disciplines. The co-location of science and engineering faculty and students in one building offers multiple opportunities for synergies and collaborations. The inter-disciplinary research efforts that are underway would be strengthened by improvements in the amount and configuration of the laboratory space available to support the mix of faculty research programs that the campus is developing.

- ***Diverse faculty and student body:*** There continues to be disparity between the diversity of university faculty, particularly in the sciences and engineering, and the demographics of the state and the country. This mismatch is implicated as one cause of the decline in science and engineering enrollments which is predicted to be a significant problem in US economic competitiveness. (see for example, *The Quiet Crisis: Falling Short in Producing American Scientific and Technical Talent* (www.bestworkforce.org)). UC Merced and the School of Natural Sciences are successful in attracting a highly diverse student body. Our ability as a research university to continue to recruit and retain such a student body would be widely recognized; this capability will position the campus to be competitive in attracting the top students from historically underrepresented groups who are rapidly growing fraction of the college-bound population. Key to this success will be continued efforts to develop a highly diverse faculty.

- ***A small public research university:*** Although the small size of UC Merced creates many challenges, it should be noted that a major problem at most of the existing UC campuses is the very large size of the faculty and student body. This large size makes significant changes to existing programs nearly impossible and creates complex bureaucracies that stifle new initiatives. For many years, UC Merced and the School of Natural Sciences will have the opportunity to combine the resources of a public research university with the flexibility of a small private university. UC Merced can provide excellent opportunities for faculty and students who value this potential to start new programs. Moreover, this potential is recognized by a number of private foundations and federal agencies who see the campus as an ideal test-bed for new models of research and academic programs.

The challenges for the School and campus include:

- ***Insufficient research space and resources:*** Development and expansion of research programs, recruitment of top quality faculty, and academic success is constrained by research space and resources. This is particularly problematic in the start-up phase of

the School of Natural Sciences (and for the campus as a whole), and will be particularly severe in AY 2008-2012), precluding recruitment of sufficient faculty to keep pace with projected student enrollments for the School and the campus. Limitations in state-funded space to create the research environment (i.e., shared facilities and infrastructure) essential for stellar research programs mandates that the administration and the faculty develop creative solutions to leverage opportunities to create research cultures that promote outstanding collaborative science.

- ***Low ratio of senior to junior faculty***: Senior faculty members are essential to provide leadership in research, shared governance and mentoring of tenure track faculty. The low numbers of senior faculty during early stages of campus developing are being addressed by faculty and administration by more senior recruitments. The administration and the faculty are working together to recognize and proactively address these issues so that the opportunities presented by the newest campus of the UC system can be realized.

D. SUMMARY OF FIVE-YEAR PROGRAMMATIC GROWTH PLAN

The faculty of the School of Natural Sciences is creating innovative, cross-cutting, multi/inter-disciplinary research and educational programs, and innovative undergraduate curricula. The current status of research themes, graduate groups, and undergraduate programs is summarized in Table D1.

Table D1: Research Areas, Graduate and Undergraduate Programs

Strategic Research Area	Graduate Group	Undergraduate Program
Applied Mathematical Sciences	AM	Applied Mathematical Sciences
Evolution and Environmental Sciences	ES, QSB	Earth Systems Science, Biological Sciences
Health and Environment	ES, QSB	Earth Systems Science, Biological Sciences
Biomedical Sciences	QSB	Biological Sciences
Biological Chemistry and Physics	CP, QSB	Biological Sciences, Chemical Sciences, Physics
Atomic, Molecular, and Optical Physics	CP	Physics
Condensed Matter Physics & Chemistry	CP	Chemical Sciences, Physics

QSB - Quantitative and Systems Biology; CP - Chemistry and Physics, ES - Environmental Systems; AM - Applied Mathematics

E. PROGRAMMATIC RESEARCH AREAS AND TEACHING

It is increasingly recognized that discoveries and solutions to complex problems will occur at the interface of disciplines in science, engineering, social sciences and the humanities. Research themes that cross disciplines and forge novel linkages will have the most impact in finding solutions to complex problems such as improving the health of the environment and human well being, developing new materials, and making discoveries about fundamental processes in our universe. Strategic planning groups included Applied Mathematics, Biomedical/biological sciences, Chemistry, Environmental Sciences, Integrative and Evolutionary Biology, and Environmental Health Sciences and Physics.

1. APPLIED MATHEMATICAL SCIENCES

Faculty providing input to the this portion of the School Strategic Plan included Francois Blanchette, Boaz Ilan, Arnold Kim, Michael Sprague, Mayya Tokman.

Overview - Mathematics is a subject of great depth and beauty. Mathematics is also crucial for developing new theories in natural sciences, engineering and social sciences. The application of mathematics to other disciplines is a particularly rich area for research and education.

Applied mathematical science involves the use of analytical and computational mathematics to solve real-world problems. Its core is comprised of modeling, analysis and scientific computing. Using these tools, applied mathematical scientists study a broad spectrum of problems across a number of disciplines. In fact, applied mathematicians are connected more closely through their shared approach and attitude toward interdisciplinary research rather than a shared interest in any particular set of problems. An explicit goal of applied mathematical sciences is to contribute significantly to other disciplines and foster interdisciplinary and multidisciplinary research and education. The absence of disciplinary barriers at UC Merced is an ideal environment for multidisciplinary research and education. Hence, UC Merced has an excellent opportunity to develop top-notch academic programs in applied mathematical science. Because applied mathematical scientists contribute to other disciplines through their research, the development of applied mathematical sciences contributes to the growth of other programs.

Research - Applied mathematicians are inherently interdisciplinary. They must be well trained in fundamentals of mathematics to model, analyze and compute solutions to real-world problems. Applied mathematics research is usually assessed through two criteria: (1) sophistication of the mathematics used and (2) novelty and importance of the application. A strong group of applied mathematicians can be a great asset to any number of scientific and engineering programs within the university where they can provide the theoretical/quantitative support or foundation.

We do not seek to build a program comprised of a specific set of sub-fields. Instead, we seek to build a strong program comprised of world-class researchers, who contribute to

the applied mathematical sciences program and a number of different programs at UC Merced. Hence, the over-arching theme encompassing the research of the founding faculty is mathematics applied to real-world phenomena. This brings applied mathematicians together with the intent to contribute to other programs of study on campus. There are many opportunities at UC Merced for interdisciplinary research under this research theme. There are several large funding sources for applied mathematics research and education. Federal sources provide funding for both education and research programs. The current faculty members (6 + 3 in progress) are well are on their way toward developing a strong research program including undergraduates, graduate students and postdoctoral researchers.

Although the founding faculty has deep expertise in the applied mathematical sciences and breadth across several disciplines, new faculty hires are needed to deepen the base of expertise and broaden the range of application areas. For example, we are seeking new hires in stochastic modeling, mathematical biology, mathematical economics and atmospheric science, among others, to forge new links with economics and management, environmental systems, the Sierra Nevada Research Institute and the developing Systems Biology Institute and Energy Institute.

Teaching - All applied mathematics faculty contribute to delivering undergraduate and graduate curricula. New faculty hires are needed to deliver and support the curricula as the demand due to our growing student population increases (see academic programs section). At present, 23 students have declared Applied Mathematical Sciences as their major. In addition, Applied Mathematics courses account for a total 238 credit hours in 2007-2008. This includes approximately 60% of *all* UC Merced undergraduates, who are taking lower division mathematics courses. This large number of enrollments requires a sufficient number of faculty members to maintain a low student-to-faculty ratio in these classes. This situation is not limited to lower division courses alone. Upper division courses and graduate courses serve a number of other programs such as physics and engineering. We may be able to depend on faculty from other programs to help contribute to the teaching needs, but mathematics courses are absolutely critical to nearly all of the majors at UC Merced. Furthermore, the effective teaching of mathematics courses is best achieved by individuals, who have both rigorous training in the subject and use the methods being taught in their research. Being an active user is an invaluable asset in conveying the "why one should care" when discussing seemingly abstract mathematical concepts. Therefore, the delivery of the mathematics curricula requires dedicated faculty support.

Cross-disciplinary and Cross-School Linkages - The applied mathematics faculty is dedicated to interdisciplinary applied mathematical science, which seeks to build linkages across disciplines and schools. The founding faculty is already involved with other programs on campus. Graduate Studies in Applied Mathematics is highly interdisciplinary; the Core faculty is comprised of 5.5 Natural Sciences faculty, and its Affiliate faculty is comprised of four members from School of Engineering, two from Social Sciences Humanities and Arts faculty, and two from Natural Sciences. We seek to strengthen current linkages and to form new ties with other programs. In particular, we are interested in forming new linkages with colleagues in electrical engineering,

mechanical engineering, computer science and engineering, life sciences, environmental systems, economics and management.

Historically, applied mathematicians have worked closely with researchers in physical sciences and engineering. Physical sciences and engineering have long adopted mathematical analysis and methods in their topics. At UC Merced we anticipate strong ties with physical sciences and engineering. Moreover, we anticipate more collaboration with researchers and students in the Energy Institute as it develops.

In addition to physical sciences and engineering, we anticipate that applied mathematical sciences will have an important role in the life-sciences program at UC Merced. Both the undergraduate major in Biological Sciences and the graduate program in Quantitative Systems Biology involve more quantitative reasoning and mathematical modeling than traditional biology programs. The applied mathematics faculty is working in collaboration with biology faculty to ensure the success of these objectives. In addition, we anticipate collaboration and look forward to involvement in the evolving Systems Biology Institute.

The area of collaboration between applied mathematics and environmental systems is rich with opportunities. In fact, several collaborations between applied math faculty and environmental systems have already begun. There are several top-notch applied mathematicians working in areas such as atmospheric science, geophysical fluid dynamics, porous media, geophysical remote sensing, and bio-statistics of ecological and environmental health. Hence, we will continue to foster collaborations and seek opportunities with future hires, who could participate actively in the Environmental Systems program and the Sierra Nevada Research Institute (SNRI). Particularly, we are supportive of a hire of an applied mathematician in the area of Atmospheric Science, who could interface between Applied Mathematical Sciences and SNRI.

There also exists potential to form collaborations with social science programs at UC Merced, most notably econometrics, management and public policy. These collaborations represent relatively new areas for applied mathematic science research. Nonetheless, the "open door" organizational structure at UC Merced facilitates exploring connections among colleagues that may become substantial collaborations in the future.

Resources – Faculty, lecturers/visiting assistant professors, space/facilities and computational administrative support are needed for academic success.

> ***Faculty:*** At a bare minimum, 20 FTEs will be needed for the applied mathematical sciences program including the undergraduate and graduate academic programs. We propose a growth rate of hiring two applied mathematics faculty per year until that number is reached. Below is a table that shows this proposed growth beyond our current faculty and assuming that our current searches are successful.

Table E1: Applied Math FTEs

	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013
FTE	**6***	**9****	**11**	**13**	**15**	**17**

* Included is Prof. Kevin Mitchell, who is a Core Member of Graduate Studies in Applied Mathematics

** Included is current search for a Lecturer with Potential for Security of Employment (LPSOE), an Assistant Professor, and an Associate or Full Professor

Lecturers and Visiting Assistant Professors: Currently, and in future years, the number of mathematics courses, in particular, the number of undergraduate service courses offered to students not majoring in applied mathematics, exceeds the teaching capacity of our FTEs. To fill this gap, we currently rely on 8 full-time Lecturers to teach lower-division courses. Lecturers are highly qualified teachers who take on a heavy teaching load and thus help ensure that our students are provided with the best possible education. We project that at least two Lecturers will be needed for the next five years to allow us to offer all of the required service courses.

In keeping with the research mission of the university, we propose the establishment of a Visiting Assistant Professor (VAP) position. The hired individual would help us provide high quality education, while contributing to our research program. The VAP position will also provide the means for other applied mathematics programs to recognize UC Merced as a place to nurture young applied mathematicians. Moreover, it provides UC Merced a means to attach its name onto young researchers going out to the academic job market.

Space and Facilities: Applied mathematicians do theoretical and computational research. Hence, new applied mathematics hires typically only need office space for their group. However, it should be noted that for applied mathematicians office space also doubles as "lab space": the office is where applied mathematicians spend nearly 100% of their research time. It is also where office hours are conducted. Therefore, it is essential for Applied Mathematical Sciences to have offices that are conducive for doing research, computing, and office hours. This includes office space for summer undergraduates, graduate students and postdoctoral fellows. Currently, our nine graduate students are occupying temporarily lab-designated space that is available through Fall 2007. Over the next five years, we plan to admit 20-30 graduate students, of which approximately 15 will be Teaching Assistants. Both Teaching Assistants and Graduate Research Students in Applied Mathematics will need access to a secure office or common space that is conducive for doing their research and holding office hours. The ability to offer adequate space is extremely important when recruiting both graduate students and faculty.

Because high-performance computing is a rich area for applied mathematical sciences research, planning is required for space, hardware-acquisition, and administration. Our faculty together with Professor Lara Kueppers has purchased a 66-node/264-processor parallel-computer cluster. This cluster will become an integral part of our graduate course MATH 233 "Scientific Computing." Sufficient space has been allocated for the cluster in the Science & Engineering building.

Undergraduate and graduate studies in applied mathematics also require open access to a computer lab for course work and research. Currently, our students have open access to the instructional computer lab in the Science and Engineering building. In the future, an open access workstation-based computer lab for graduate studies would best accommodate the computing needs of our graduate students, other students enrolled in our computational courses, and potentially other courses as well.

Computational Administrative Support: While faculty start-up funds have been used for building a modern parallel-computation cluster, long-term financial support for its administration is required. Having an Information Technology person on-site to support the computational administration of the Applied Mathematics cluster, and potentially others, will ensure an optimal use of our resources and will benefit both our educational and research missions. The School of Natural Sciences has hired a full-time system administrator to set up databases and infrastructure for all academic programs. It is expected that faculty research grants and start-up funds will be used to help pay for around 10% of the system administrator's time for administration of the applied mathematics cluster.

2. BIOMEDICAL/BIOLOGICAL SCIENCES

This portion of the School of Natural Sciences Strategic Plan covers the life sciences related to Biochemistry, Molecular and Cell Biology, and Biomedicine and was developed by the following faculty: Miriam Barlow, Jinah Choi, Michael Cleary, Michael Colvin, Marcos Garcia-Ojeda, Andy LiWang, Patti LiWang, Jennifer Manilay, Monica Medina, Matt Meyer, David Ojcius, Rudy Ortiz.

Overview - Biology is on the brink of a fundamental transformation from a primarily "descriptive" study of individual components of biological systems, to a science based on creating a comprehensive and ultimately predictive understanding of biological systems. This so-called "systems" approach to biology is already dramatically changing how biological research is done, leading to new connections with the physical, mathematical, and computational sciences. This new biology offers the promise of a much more complete understanding of living systems and ultimately new treatments for complex diseases such as asthma, diabetes, and cancer.

This new biology is built on several themes: 1) acquisition of comprehensive, quantitative data sets on living systems, such as whole genome sequences, protein expression rates, and complete maps of metabolic and regulatory pathways, 2)

development of mathematical models for integrating and evaluating such data, with the goal of building models that can predict novel or unexpected properties of biological systems and 3) recognition of the central role of evolution in studying and understanding organisms, pathways, genes, and disease. Finally, this "new biology" requires very close partnerships with the physical and mathematical sciences. This need for a highly multidisciplinary approach constitutes an important barrier to progress in quantitative systems biology; many universities have highly compartmentalized research programs and few undergraduate or graduate programs provide truly multidisciplinary training.

UC Merced has an excellent opportunity to develop biological and biomedical sciences research and academic programs at the forefront of this field. The small size and lack of disciplinary barriers at UC Merced have already been fostering a number of multidisciplinary research programs (see below). Furthermore, this new biology will be greatly enabled by many of the other initial academic programs and research efforts at UC Merced, such as the applied mathematics, earth systems science and bioengineering programs, the Biomedical Sciences Research Institute, the Sierra Nevada Research Institute, and the Center for Computational Biology.

Research - The biological and biomedical sciences at UC Merced encompass several research themes described below. Linking all of these themes is the strategy of using methods that integrate large data sets, such as genomic or proteomic data, or produce quantitative data at the single cell or even single molecule level. Another linking theme is the goal of quantitative characterization of biological processes with ultimate aim of predictive models.

1. Predictive Understanding of Cellular Interactions and Cell Fate Decisions

An ultimate goal of cell biology is to achieve a complete understanding of the biochemical pathways underlying cellular decisions, including developmental choices and response to outside stimuli. Research in cell biology at UC Merced spans a wide range of specific research topics, from the development of immune system cells, to the evolution of bacterial antibiotic resistance to symbiosis in marine systems. New research questions are being made accessible by technologies that allow comprehensive genomic, proteomic, and metabolomic characterization, in some cases down to the single cell level. A combination of experimental investigation using these new tools and computational modeling of the interacting pathways will provide data to determine the mechanisms of cellular responses to exogenous factors such as infection, oxidative stress, growth factors, as well as internal factors such as epigenetic state or cell age. This knowledge will allow the development of new therapies to treat diseases, including the potential of chemoprotective agents against inflammation and aging.

The understanding of cell signaling and cell fate decisions also has important biomedical applications because the ontogeny and maintenance of multicellular life depends on exquisitely complex developmental process in which undifferentiated stem cells give rise to specialized cell types. Understanding this process promises to provide new treatments for many complex disease states related to developmental

failures. Moreover, because of their ability to generate new specialized cells, stem cells hold the potential to treat a vast array of health problems, including spinal cord injuries, Parkinson's disease, diabetes, and many others. Elucidating the complex mechanisms by which extrinsic and intrinsic signals determine the proliferation or differentiation of stem cells is inherently a systems-level challenge, and will require new technologies for collecting data on cell populations and individual cells, and new methods to build models of cell decision processes.

2. Complex Diseases

Complex diseases are defined as diseases that are influenced by the actions of multiple genes, their interactions with each other and with the environment. Examples include metabolic disease, cardiovascular disease, Alzheimer's disease, Crohn's disease, persistent infection, cancer, diabetes and asthma. These diseases can only be fully understood in multidisciplinary approaches that include: identifying communities with increased risk due to their genetic backgrounds, determining the environmental factors that increase disease risk and understanding the cellular and molecular mechanisms underlying the increased susceptibility that can offer possible treatments.

The Central Valley has a high rate of such diseases and provides a microcosm of the health challenges of the entire state and nation. A strong research program on complex disease would foster collaborations with healthcare providers in the Central Valley. Conversely, the local community would provide unique cohorts for studying strategies for treating or reducing the incidence of these diseases. This program would have strong synergies with emerging UCM Merced programs in environmental science, psychology, sociology, and economics and would have many links to future health professional programs.

3. Biochemistry and Chemical Biology

Central to biology's transition from a descriptive to predictive science has been the growing understanding of biological processes in terms of the underlying chemical mechanisms. This transformation has been made possible through cross-fertilization with the chemical sciences. Advances in determining the structural and functional properties of macromolecules have largely come from the application of physical techniques such as spectroscopy and crystallography to biological systems. Furthermore, many of the most exciting recent advances in the biological sciences, including the ability to image and analyze processes occurring in single cells and/or single macromolecules or assemblies, have become possible only through the development of new ultra-sensitive analytical techniques. Therefore the development of a vibrant, cutting-edge research program in biochemistry must draw on individuals trained in the classic chemical disciplines of organic, physical, and analytical chemistry as well as biochemistry, a fundamentally interdisciplinary field concerned with the structure, function, regulation, reaction mechanisms, and energetics of biologically relevant molecules.

Research at the interface between chemistry and biology at UC Merced falls into two categories: Biochemistry and Chemical Biology. Biochemists seek to understand the chemical structures and reactions underlying biological processes. Chemical biologists seek to harness the complex synthetic machinery of the cell to accomplish chemistry that is impossible to achieve in vitro. While chemical biology is a new and developing field, it holds promise as a means of developing new pharmaceuticals, novel biological technologies from biosensors, new molecular biology techniques, and means of dissecting cell signaling pathways. Chemical biology is a field that is truly cross-disciplinary between biology and chemistry, and offers one of the best avenues by which UC Merced can craft truly interdisciplinary research.

4. Cross-disciplinary and cross-school linkages Multidisciplinary research is a founding principle of UC Merced and the biological/biomedical sciences offer many opportunities for cross-disciplinary and cross-school collaborations. The fields of chemistry and biology have had a long and fruitful partnership, leading to a detailed understanding of many of the chemical processes underlying life. Recently, there has started to be a reciprocal flow of information from biology to chemistry with biology providing "metaphors" for new chemical strategies, such as self-replicating chemicals. Ultimately, biological examples could provide more detailed designs and design principles for practical chemical applications such as catalysts or detectors. Likewise, chemistry informs the biological sciences by providing accurate chemical means of monitoring biological systems. Chemical biology could also have strong synergies with the bioengineering program in the School of Engineering. Similarly, large-scale, inexpensive DNA sequencing have placed evolutionary approaches at the center of modern biological research. The genomes of hundreds of eukaryotic and prokaryotic organisms are being sequenced at a very fast pace and experimental and analytical evolutionary methods are being used to asses the functions and potential of genes and genomes. Those technological advances have caused evolutionary biology to advance from studies that are merely interesting to those that have important applications such as engineering proteins, developing improved strategies for treating diseases, and identifying the underlying causes of genetic disorders. The UC Merced faculty is using evolutionary biology to understand a range of problems ranging from the origins of disease to the emergence of antibiotic-resistant microbes. This research program also has the potential for strong linkages to programs in Integrative Biology and Earth Systems Science, and Environmental Engineering.

Nearly all aspects of biomedical research have repercussions in the humanities and social sciences: ethics, economics, psychology, philosophy, and cultural studies. These components are strongly emphasized in the Human Biology degree, but there are good prospects for more broad synergies between SSHA and the biomedical sciences.

There are large funding sources for biomedical research. Federal agencies such as the National Institutes of Health provide approximately $30 billion per year and research funding is also available from many foundations and private companies. Nevertheless, these funding sources are all highly competitive and success requires a strong research

program. The previously described research themes, cell signaling, cell fate decisions, and complex diseases, are well aligned with the newest academic and research priorities of the funding agencies and foundations. Most major research universities are also creating research programs in quantitative and systems biology, but their natural advantages in having already established research programs and facilities may be somewhat offset by having larger institutional barriers to building multidisciplinary research efforts.

Teaching – The faculty in Life Science**s** contribute to undergraduate programs in biological sciences and the QSB graduate program.

Undergraduate - Biological Sciences: The Biological Sciences is the largest undergraduate major at UC Merced. By AY07-08, there were 480 declared Biological Sciences majors. Biological Sciences is currently organized into three emphasis tracks: Molecular and Cell Biology, Human Biology and Integrative Biology. For AY08-09, we plan to add three additional emphasis: Biochemistry (study of the molecular basis for life), Cell & Developmental Biology (study of the fundamental components of multicellular life), and Microbiology & Immunology (study of the diversity, structure, evolution, method of transmission, replication, epidemiology, and mechanism of pathogenesis of microorganisms and their interplay with the host immune system.). Biochemistry may develop rapidly into a separate major. Based on enrollments at other universities and UC campuses, we expect high enrollments all three of areas. Since these new emphasis and potential majors are almost entirely built from courses already offered for the original Biological Sciences major, they require minimal new resources.

Courses developed for the life sciences majors and graduate groups are also relevant to a number of majors outside biology. A number of the bioscience core courses, such as Molecular Biology and Biochemistry will be necessary for other majors such as the Chemical Biology emphasis area in the Chemical Sciences major and the Bioengineering degree offered by the School of Engineering. Earth System Science majors with an ecosystems and conservation biology emphasis will take lower division and core biology classes, and upper division IB and ESS courses in this emphasis area will often be cross-listed. Additionally, the biological sciences program offers a number of lower division general educations courses in biology and health that will be of interest to students from any major or school.

***Graduate Emphases*:** The faculty associated with the Biological/Biomedical Sciences participate primarily in two graduate emphases: Quantitative and Systems Biology (QSB) and Bioengineering and Small-scale Technologies (BEST). These are both rapidly growing graduate groups that have been successful in attracting academically strong students. The research priorities for these groups are described in their separate research plans.

Most graduate programs in the biomedical sciences are very discipline-oriented, e.g. biochemistry, cell biology, etc. This restricts the type of students entering the program and limits the training opportunities for students in the program. In contrast, the Quantitative and Systems Biology graduate group at UC Merced brings together faculty from a wide range of disciplines with broad expertise to investigate the complex systems and networks responsible for the biological functions of cells, tissues, organisms, populations, and ecosystems. The current QSB faculty is drawn from both the Schools of Natural Sciences (17 members) and Engineering (5 members) covering disciplines including molecular and cell biology, evolutionary biology, genomics, proteomics, signal transduction, experimental technologies, and computational biology. QSB students are involved in a wide range of biomedical sciences research projects, and this will continue to grow as new faculty join the graduate group. The doctoral program emphasizes quantitative analyses at multiple levels of biological systems, development and use of novel model systems, and computational and analytical approaches for the study of biological processes.

Resources – Resource needs to build excellence in this program include faculty, core facilities and experimental research laboratories.

Faculty: The first 12 faculty in biomedical/biological sciences initiated planning and development of the research programs described above; additional faculty are needed to broaden the base of expertise into new areas not currently covered and to deepen the base in selected research areas. The following table lists specific high priority biological/biomedical sciences hires for the next five years.

Table E2: Summary of Proposed Biomedical Sciences Hires for the Next Five Years

	Cell Fate	Complex Diseases	Biochemistry/ Chemical Biology
Current Faculty[a]	6	7	4
UCM collabs.	BioEngineering	BioEngineering	Chem, BioEng, ESS
Institutes	BMRI[c]	BMRI	WCI, BMRI, SNRI
2007-2008	Developmental Biology[b]	Complex Disease Develop. Biology[b]	--
2008-2009	Neurobiology	Infectious diseases Physiology	Molecular Biology
2009-2010	Cell Biology[b] Microbiology[b]	Cell Biology[b] Microbiology[b]	Biochemistry Chemical Biology
2010-2011	Immunology[b] Cancer Biology[b] Computational Biology[b]	Immunology[b] Cancer Biology[b] Mol. Bio/Genetics[b]	Computational Biology[b] Mol. Bio./Genetics[b]

2011-2012	Systems Biology[b] Neurobiology	Systems Biology[b] Epidemiology	Chemical Biology
2012-2013	Cell Biology[b] Develop. Biology[b]	Cell Biology[b] Disease Biology	Biochemistry

[a] Current Faculty includes individual faculty counted in more than one category; and the numbers are based on only the 12 faculty included in the biological/biomedical sciences planning group. For anticipated hires the "[b]" indicates that position appears in more than one research theme. [c] BMRI: Biomedical Research Institute

Core Facilities: The research programs described above will require continued development of research facilities. Good progress has been made over the past year in developing life sciences research resources; however, the facilities require continued development, and several facilities are needed that have yet to be developed. The vivarium opened for animals in Summer 2007 and groups of faculty several types of have purchased shared instrumentation that are intended to be part of the cores, including the Genomic Center of Excellence and Quantitative Cytometry Core Facility. Formal procedures for recommendation of these facilities as official University research cores are under review. As current core equipment has been purchased and is now maintained by current faculty start-up funds, new faculty start-up packages could include funds for salary support for core managers and maintenance agreements. University financial support for the salary of core managers, and improved administration, such as recharge set up for UC and non-UC affiliates is key for the success of any research core. The full establishment of core facilities is crucial for the success of research progress, recruitment and retention of faculty and should be a high priority for the School and the Office of Research, under the direction of the Vice Chancellor for Research.

Table E3: Facilities Required for Biological/Biomedical Sciences Research

Core	Cell Fate	Complex Diseases	Biochemistry/ Chemical Biology
Genomics	√√	√	
Quantitative Cytology and Imaging	√	√	√
Proteomics (Mass Spec.)	√√	√	√
Proteomics (Microarray)	√	√√	√
Animal (Vivarium)	√	√	
Animal (Transgenic)	√√	√	
Computational support	√√	√	√

Facilities shown in bold are under development. Two checkmarks, very strong need; single check mark, some need.

Laboratories: Space for biomedical/biological laboratory research is a challenge. Core facilities required dedicated shared space that should not come at the expense of laboratory space of individual faculty. Each of the new faculty will require a bare minimum per CPEC average of ~700 square ft (assuming about 50% senior faculty). The reality is that it will be necessary to offer, on average, twice that amount to be competitive and to be able to recruit stellar faculty at all levels. Faculty recruitment and programmatic success requires resources in the form of start-up packages, laboratory and office space, and institutional investment for equipment and staff. Finally, each of the cores described above will require at least a 0.5 time staff member. Typical start-up packages in the life sciences are in the range of $500K - $1M, even for junior faculty.

Overall, the proposed life science hiring plan will require 10,000-15,000 square feet of new office and laboratory space over the next 5 years. The seven proposed core facilities will require approximately 4,000 sq. ft. of additional laboratory space. There are several options for acquiring this further space. These include acceleration of the timetable for SE II, use of space at Castle, and the use of temporary buildings on campus. The exact mix of these alternatives involves decisions by the UC Merced administration, and is therefore beyond the scope this strategic plan.

3. CHEMISTRY

Natural Science faculty providing input to this portion of the School's Strategic plan included Anne Kelley, David Kelley, Matt Meyer, Meng-Lin Tsao, and Tao Ye.

Overview - Chemistry is often known as "the central science" because of the key position it occupies in modern science and engineering. Most phenomena in the biological and earth sciences can be described in terms of the chemical and physical behavior of atoms and molecules, and chemical principles also underlie much progress in medicine and engineering. In addition, chemical systems are fascinating and often beautiful in their own right. George Whitesides, in his 2007 Priestley Medal address, states that "Chemistry is now the natural home of many of the most engaging problems in fundamental science and of the problems in applied science about which society cares the most." Herein we give a few examples of how chemistry has had a profound impact on other fields of science and technology. Just several years after the inception of UC Irvine, Sherwood Rowland and Mario Molina (Nobel Prize, 1995) used physical chemistry approaches to unravel the chemical mechanisms of ozone depletion. This discovery, which helped to pull us back from the brink of an environmental catastrophe, played no small part in catapulting Irvine to research powerhouse status. Chemistry plays an essential role in the development of nanoscience and technology due to chemists' expertise in understanding and controlling matter at the atomic and molecular scale. It is no coincidence that almost all the exciting nanomaterials, from quantum dots to carbon nanotubes to semiconductor nanowires, have been pioneered by chemists. The intimate connections between life sciences and chemistry result from the prowess of chemists at manipulating and measuring molecules, the building blocks of life. A recent example is

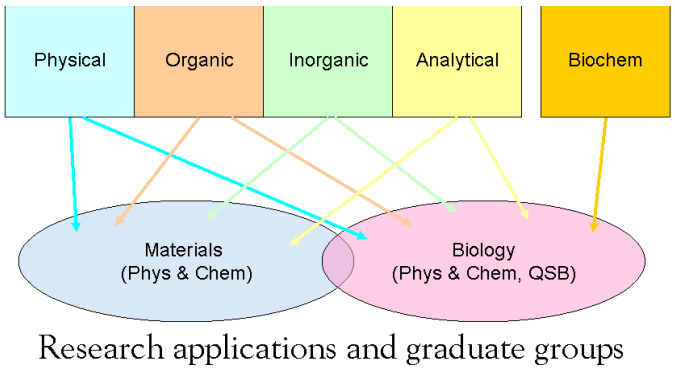
Bertozzi's chemical manipulation of oligosaccharides in biological systems, which opens up new avenues to understanding and regulating complex cell surfaces. Analytical chemists such as John Fenn (Nobel Prize, 2002), were responsible for developing mass spectrometric analyses of biological macromolecules, a cornerstone in proteomics. The advancement of single molecule spectroscopy by Sunney Xie, a molecular spectroscopist by training, has stirred much excitement in biophysics as it affords access to unprecedented details of life processes at the single molecule level.

Because of the indispensible role of chemistry as a core discipline in science, one would be hard-pressed to think of any highly respected comprehensive research university that does not have a strong chemistry program that grants both bachelor's and Ph.D. degrees. Chemists may be classified according to their subdiscipline and/or by the nature of the problems on which they work. The four traditional subdisciplines of chemistry are organic, inorganic, physical, and analytical:

- Organic chemistry is the chemistry of carbon-based compounds. Organic chemists are concerned with synthesizing useful chemical compounds, developing new reactions to better achieve challenging syntheses, and determining the physical principles that are responsible for chemical behavior. Organic chemists are actively engaged in the synthesis of new materials for energy harvesting and storage, the manipulation and understanding of biological processes, and the development of efficient and ecologically benign catalysts and reactions.
- Inorganic chemistry is the chemistry of chemical compounds that are not primarily carbon-based. Inorganic chemists determine the structures of inorganic molecules, study their reactions, and develop procedures for their synthesis. The fundamental principles are applied to problems in environmental chemistry, bioinorganic chemistry, and solid-state materials chemistry.
- Physical chemistry applies the fundamental laws of physics to understand the properties of chemical compounds and the basis of chemical reactivity. Physical chemists study the energetics of molecular and macroscopic processes, the dynamics of chemical reactions, quantum chemistry, and interactions of molecules with light (spectroscopy, photochemistry, and photophysics) using techniques that are experimental, theoretical, and/or computational.
- Analytical chemistry concerns the chemical analysis of substances. Analytical chemists develop instrumentation and methodologies to determine what chemical compounds are present in a sample and/or how much is present. Modern analytical chemistry is particularly concerned with very small systems, down to the single-molecule level, as well as applications to biology (proteomics, genomics) and environmental monitoring.

At UC Merced, we have the unique opportunity to build a modern chemistry program that combines disciplinary rigor and interdisciplinary reach. Chemical sciences require systematic training. All four subdisciplines should be represented to some extent in order to have an externally recognized chemistry program that incorporates all of the course work required for an American Chemical Society-accreditable major, although the four areas need not be equally weighted. Reflecting the expansive nature of chemical research and the interdisciplinary emphasis at UC Merced, the faculty has decided to focus on recruiting chemists working on problems in two broadly defined areas, biology and materials (Figure E1). The representation of traditional disciplines should not be viewed as an impediment to interdisciplinary research as we intend to recruit chemists who can bring novel chemical solutions and perspectives to materials and biology, just as the aforementioned prominent chemists have done.

Figure E1. Chemistry: Disciplinary and Inter-Disciplinary Synergies



Biochemistry is a discipline closely allied with both chemistry and biology but distinct from both. Some universities have a combined department of chemistry and biochemistry while in others biochemistry is a separate department or is associated with another department. For the purposes of this year's planning exercise, biochemistry has been associated with molecular and cell biology rather than with chemistry. Two searches are currently underway for faculty working in the area of materials chemistry, which may belong to any of the four sub-disciplines.

Research - Materials Chemistry is defined by the American Chemical Society journal in this field, *Chemistry of Materials*, as "Solid-state chemistry, both inorganic and organic, and polymer chemistry, especially as directed to the development of materials with novel and/or useful optical, electrical, magnetic, catalytic, and mechanical properties." Materials chemists may be focused predominantly on synthesis (organic or inorganic chemistry) or characterization (analytical or physical chemistry). These areas offer the possibility of many different types of collaborations, both within UC Merced between Natural Sciences and Engineering and at other nearby institutions including Hewlett-Packard, LLNL, and possibly NASA/Ames in the near future. This type of research is very well funded and we expect it will continue to be well funded in the foreseeable future. The Bush administration's American Competitiveness Initiative (ACI) commits to doubling, over 10 years, funding for research at key federal agencies that support physical science and engineering: NSF, DOE's Office of Science, and NIST. Part of the ACI is the Advanced Energy Initiative, which provides for a 22% increase in funding for clean-energy research at the DOE. Materials chemistry will be key to advances in new energy sources. Potential research areas for future Materials Chemistry hires include:

- *Organic Electronics*: Design, synthesis, and physical properties of materials for organic light-emitting diodes (OLEDs), thin film transistors, and liquid crystal displays
- *Solar Photovoltaics*: Design, synthesis, and physical properties of materials for organic, inorganic, or hybrid solid-state devices and/or electrochemical cells
- *Photonic Materials*: Design, fabrication, and properties of materials for frequency conversion of lasers, optical limiting materials, contrast agents in nonlinear optical imaging technologies, electro-optic modulation, and photonic bandgap crystals
- *Batteries:* New materials to enable lightweight, high capacity, multiply rechargeable battery technology
- *Heterogeneous Catalysts*: Solid-state materials that catalyze a variety of desired chemical reactions
- *Structural Materials:* Design, synthesis, and characterization of new materials having desirable properties (light weight, high strength, environmentally benign, biocompatible, *etc*.)
- *"Smart" Materials*: Synthesis, characterization, and engineering of materials that can respond adaptively and autonomously to changes in their condition or the environment
- *Plasmonics*: Materials for, and study of, phenomena based on the coupling of light to the plasma oscillations of conduction electrons in small metallic nanostructures, and their coupling to other materials

The ACS Division of Biological Chemistry defines this subfield as "using the principals [*sic*] of chemistry to assist in the development of a deeper understanding of biological processes ". Much of the recent dramatic progress in the life sciences has been driven by quantitative approaches and a molecular-level understanding of complex biological systems. Experimental, computational and theoretical methods and techniques from chemistry have played a significant role in these advances. In addition, the flow of knowledge and inspiration runs both ways: challenges posed by specific biological problems are driving the development of new analytical tools, prompting advances in the physical and chemical sciences. Biological chemistry has undergone explosive growth in recent years as experimental and computational tools from the physical sciences have become widely applied to biological problems. Biological chemistry is explicitly interdisciplinary between the physical and life sciences, and there should be extensive opportunities for collaboration across these groups. In addition, at least some of the biological chemistry faculty is expected to have research interests that overlap engineering, particularly Bioengineering. The development of a strong presence in biological chemistry would position our school for center grants and other translational research initiatives. Biologically related chemistry is a large area of chemistry research that is well funded, largely by NIH but also through other agencies. Potential areas for future Biological Chemistry hires include:

- *Nucleic acid replication, damage and repair*
- *Novel modes for drug delivery*

- *Development of ultrasensitive bioanalytical techniques, particularly for single molecule/single assembly measurements and/or high throughput screening*
- *Single molecule studies of molecular motors, DNA/RNA dynamics, transcription factor binding/functioning, viral genome packaging, ion channel transport etc.*
- *Organized chemical systems that imitate the functioning of biological cells*
- *DNA and/or other biological macromolecules as scaffolds for fabrication of organized structures*
- *Protein folding*
- *Molecular recognition*
- *Novel uses of combinatorial techniques at the interface of chemistry and biology: aptamers, phage display, novel approaches to screening and combinatorial synthesis*
- *Atomistic modeling of biological systems (channels, membranes, receptors)*
- *Membranes and associated phenomena including fusion, exo/endocytosis, pore formation and functioning, lipid rafts*

Teaching – The Chemistry faculty have broad teaching responsibilities, including graduate students in the Chemistry and Physics Graduate Program and undergraduates majoring in chemical sciences. In addition, the chemistry faculty teaches preparatory lower division courses in chemistry for science and engineering majors, constituting a large service load for the campus.

Undergraduate - Chemical Sciences Major: In AY 2006**,** UC Merced began accepting majors into the B.S. degree program in the Chemical Sciences. All of the programs meet the requirements for approval by the American Chemical Society. Students who complete an approved curriculum may obtain a certified degree, a valuable credential which serves as national-level recognition for successfully completing a rigorous academic chemistry curriculum in an ACS-approved department. ACS accreditation may be sought upon graduation of the first majors and we anticipate accreditation in 2010. The curriculum is designed to meet the needs of students who plan to end their formal education with a bachelor's degree as well as those who wish to go on for an advanced degree. The UC Merced chemistry B.S. graduate will be well prepared to pursue a career in chemistry or an allied field.

Students pursuing a B.S. degree in Chemical Sciences have the opportunity to pursue interdisciplinary areas within a degree program that is still focused on chemistry. Our B.S. degree in Chemical Sciences offers four emphasis tracks: Biological Chemistry, Environmental Chemistry, Materials Chemistry, and "pure" Chemistry. All four tracks share the same lower-division courses and some of the core upper-division courses. While some of the required and elective courses for the Biological, Environmental, and Materials tracks are offered by faculty in other disciplines in the Natural Sciences and Engineering, there are four lower-division and approximately eight upper-division courses that must be taught by the chemistry group. The lower-division courses are each offered every semester in order to meet the needs of not only the chemistry majors but also the other Natural Sciences and Engineering

students for whom these courses are required. The upper-division courses each need to be offered once each year. Therefore, a total of 16 undergraduate chemistry courses must be taught each year, requiring eight faculty FTE. While instructors can cover a few of the lower-division courses, the chemistry faculty feel strongly that instructors should only teach in Chem 1 and Chem 2, leaving a bare minimum of 5.5 tenure-track faculty FTE to cover undergraduate teaching needs alone. In addition, all of our emphasis tracks require at least two units of research, and undergraduate research supervision is highly intensive of faculty time.

Graduate Programs: At present, Ph.D. programs in chemistry are administered under the umbrella "Interim Individual Graduate Program" that was put in place at UCM's inception. A combined "Physics and Chemistry" emphasis area currently involves 14 faculty (five chemistry, six physics, and three engineering) and 12 graduate students (five chemistry and seven physics). Separate courses of study are offered in Physics, Physical Chemistry, and Organic Chemistry. Physics programs normally require more extensive graduate course work than chemistry programs, and we are currently taking advantage of this by having our physical chemistry students take some of the physics graduate courses, particularly quantum mechanics. However, this combined graduate group is certainly not an ideal situation from the standpoint of either graduate student recruiting or graduate education, and we expect that when we apply for stand-alone graduate program status, it will be as separate physics and chemistry Ph.D. programs. Even if we limit our course offerings to a bare minimum of three to four advanced courses in each of the four core subdisciplines, a few of which can overlap, and offer some of these courses only once every two years, eight to ten graduate chemistry courses would have to be offered each year, requiring four to five faculty FTE. This, combined with the undergraduate teaching requirements outlined above, leads to the conclusion that a faculty size of ten to eleven is the minimum required to offer undergraduate and graduate programs in chemistry. This conclusion is in keeping with data from the American Chemical Society showing that the smallest Ph.D.-granting chemistry departments in the U.S. have at least ten full-time faculty. Thus, much of this strategic plan is based on the facts that Merced's current IIGP is an interim program that will soon expire, and we need to be able to propose a graduate program in Chemistry at that time. This will involve broader coverage of the discipline and require at least ten to eleven faculty.

Resources - Development of a stellar academic and research program in chemistry requires faculty, laboratory space for faculty, and shared core facilities.

Faculty: A five year growth plan for faculty recruitment has been developed. As described above, the chemistry group needs to grow to a minimum of ten to eleven faculty by AY 09-10 in order to offer both the undergraduate major and a viable graduate program. The current faculty plus the two currently open positions give us a total of seven; therefore we request three high priority hires, plus one lower priority, for AY 09-10. Thereafter, approximately one new faculty member per year for the next four years will allow us to diversify our research programs and undergraduate and graduate course offerings. At the undergraduate level, we would like to introduce

some more specialized upper-division elective courses as well as versions of organic chemistry and/or physical chemistry geared toward students with biological interests, as are commonly offered at most other research universities. At the graduate level, we would also like to offer more specialized courses and be able to offer all core graduate courses on an annual basis. The new hires should be distributed among the four subdisciplines (organic, inorganic, physical, and analytical) and between the two application areas (biological and materials) as summarized below:

Table E4: Summary of Proposed Chemistry Hires for the Next Five Years

Faculty	Research areas	Subdiscipline
Current	Kelley, A: materials	Physical/analytical
	Kelley, D: materials	Physical
	Ye, T: materials/bio	Physical/analytical
	Meyer, M: bio	Organic
	Tsao, ML: bio	Organic
2007-2008	Materials (2)	Organic or inorganic preferred
2008-2009	Bio or materials	Inorganic or organometallic
	Bio	Analytical
	Bio	Organic
	Bio or materials	Theoretical (physical)
2009-2010	Materials or bio	Theoretical (physical)
2010-2011	Bio or materials	Theoretical (physical)
2011-2012	Materials	Organic
2012-2013	Bio (single molecule)	Physical

Whenever possible, all positions should be searched at open rank. We have no tenured faculty in any of the sub-disciplines except physical, and senior leadership in these areas is much needed. However, recruiting top-notch tenured faculty will be very challenging, particularly in experimental fields that are highly resource-intensive. We feel that the most profitable strategy is to attempt to recruit tenured faculty but accept that many of our new hires will have to be made at the Assistant Professor level.

Facilities and space: Laboratory research space poses a huge challenge. Competitive offers will require allocation of significant amounts of laboratory space. This is particularly true for senior-level candidates. Most new experimental hires will require 500-1500 sq ft. of laboratory space which will generally be some mixture of "wet" (i.e. with sinks and fume hoods) and "dry" space. SE I will likely fill up with the current year's faculty hires. Following this year, further space will be needed. There are several options for acquiring this further space. These include acceleration

of the timetable for SE II, use of space at Castle, and the use of temporary buildings on campus. The exact mix of these alternatives involves decisions by the UC Merced administration, and is therefore beyond the scope this strategic plan.

Core Facilities: Many new chemistry hires will require the services of core facilities. Any organic chemist will require NMR, which we already have, although only at Castle. Many materials chemists will make use of our existing excellent electron microscopy facilities, the recently acquired powder x-ray diffractometer, and the clean room being built in SEI. Major core facilities that potential hires are likely to need, and that we do not currently have or do not have in working order, include high quality mass spectrometry, single crystal and thin-film x-ray diffraction, and circular dichroism. Other instruments that are currently in the laboratories of individual faculty members, but would be widely used and should be reproduced as core facilities develop include a high quality UV-VIS-NIR and a fluorimeter.

4. Environmental Sciences, Integrative and Evolutionary Biology, and Environmental Health Sciences

Overview - Environmental Sciences and Integrative and Evolutionary Biology were established as initial areas of research and education excellence at UC Merced. Earth Systems Science (ESS) was designated as one of the first undergraduate majors in Natural Sciences (SNS), Environmental Engineering (ENVE) as a first major in the School of Engineering (SE), and the Environmental Systems (ES) graduate group as a joint SNS and SE graduate program awarding M.S. and Ph.D. degrees. In 2006, the Integrative Biology (IB) track within the Biological Sciences (BIS) was approved for study of comparative and evolutionary biology. A revision of the ESS undergraduate major is underway, with the goal of strengthening the interdisciplinary nature of the major through cross-school faculty support to reflect the broad and diverse nature of environmental sciences. The Sierra Nevada Research Institute (SNRI) is a cross-school institute through which faculty, researchers, and students conduct basic and applied research on environmental issues, using the San Joaquin Valley and the Sierra Nevada as their outdoor laboratory. Existing research collaborations and coordinated teaching efforts between SNS and SE in this area, as well as recent successes in faculty recruitment in the School of Social Sciences, Humanities and Arts (SSHA) in the areas of environmental policy and economics emphasize our cross-school, interdisciplinary nature. Environmental Health Sciences, focusing on research at the intersection of environment and health, is an emerging area at UC Merced. Given the breadth of research and education encompassed in this area, a major challenge for program development is to identify and build strategic areas in which UC Merced can excel while providing sufficient program breath and depth to support undergraduate majors and graduate education. The following plan was developed based on previous years' plans and consideration of strategic plans from graduate groups, SNRI, and faculty from other schools with interests in environmental research.

Research - A central philosophy of the environmental program area is an integrated approach to the study of physical, chemical, and biological processes in natural and engineered environments. Research and education components focus on the quantitative understanding of the Earth as coupled systems of atmosphere, hydrosphere, lithosphere, and biosphere, and of biological systems as shaped by evolution and the environment. These themes intersect with human and ecosystem health. Such integrated studies require a balance of disciplinary expertise and interdisciplinary connections. This requirement translates to a need for a large and diverse faculty assemblage -- one that can support the multifaceted components of priority research themes and whose members will contribute to multiple majors and programs. Current SNS research areas include *Global Change Science*, *Climate and Watershed Resources*, *Biocomplexity and Evolution*, *Atmospheric Pollution and Health*, and the *Ecology of Infectious Disease*. Continued expansion of complementary faculty in SSHA and the future School of Management is viewed as an integral component of program development to address the human dimension of environmental systems, along with continued synergy with SE. The research themes are described in more detail below:

a. Environmental Sciences

Global Change Science - Ecosystems encompass living organisms and the abiotic environment they inhabit. The science of global change employs a genome- to ecosystem-level perspective to understand interactions among organisms and the environment with an emphasis on discovering the effects of climate change, land use, pollution, biodiversity loss and other environmental pressures on ecosystems. Research in this area examines both past environmental changes and their impact on evolution as well as modeling future global change scenarios. Global change science examines how these alterations influence the interactions among organisms, ecosystem processes, and other Earth System components such as oceans, the atmosphere, and soils. Both significant needs for new knowledge in stressed regional and global ecosystems and new research initiatives in this region make this a compelling opportunity for UC Merced. For example, the California Ecological Observing Network (CALEON) planning group has proposed the San Joaquin Valley and Southern Sierra as a focus for new research infrastructure. Extramural funding in global change research initiatives and environmental biology from NSF, EPA, DOE, NASA, USDA, and other agencies are currently on the order of $3 billion. We have begun to develop expertise in the area of global change science, with faculty in evolutionary and conservation genetics, ecosystem and fire ecology, and macroecology. In AY 2007-2008, we are searching for three positions in ecology, with up to two senior faculty appointments (Table E6). We anticipate that these new faculty may contribute to this area and that some fraction of the new senior faculty will provide leadership and direction. Forefront advances in this field are occurring at the interface between biological systems and physical sciences. The addition of new faculty in the area of ecology strengthens expertise in environmental life sciences. In order to continue to develop a nationally and internationally competitive program grounded in both life and physical sciences, we need to continue to build complementary expertise in the area physical surface

processes/ecohydrology (Table E6). Future positions in soil biogeochemist, conservation biology, and others listed in Table E6 would further strengthen the global change science research area.

Climate and Watershed Resources - Water is a critical resource on our planet and an essential component of planetary function where it serves as a solvent, a transporter, and a reactant, as well as a basic requirement for life. From an anthropogenic perspective, water is a critical resource, for drinking water, agricultural and industrial use, energy production, and recreation, thus making it an important commodity. There is growing awareness that the combination of impending climate changes and increased human demand for water will soon collide, particularly in California and the western U.S. where high quality water is already a limited resource in many areas. UC Merced is well poised to have a signature impact on integrated science, engineering, and management issues related to water as a critical resource including relationships between climate change and the regional hydrologic and carbon cycles, fundamental understanding of molecular, chemical, and biochemical processes the impact water quality, and integration of basic research into water resource management, sustainable agricultural activities, and economic development in the Central Valley. This thematic area already has a strong component in SE and formed the initial core of the ES graduate group programs. We envision that a faculty group in SSHA with interests in economics, policy, law and social science related to the environment would strengthen cross-discipline research and education. Faculty in the School of Management would also play an important role in the development of interdisciplinary links in areas of natural resource management, particularly related to water and biological resources. We support a proposed cross-school position in resource conservation and management (Table E5). Growth in this thematic area requires additional faculty strength in SNS in surface processes/ecohydrology noted above, and in plant biology/ecology and environmental microbiology (Table E6). Future recruitments in conservation biology and other areas in Table E6 would further strengthen research and teaching in this area.

Table E5: Current Environmental Science and Integrative and Evolutionary Biology Faculty FTE's Across Graduate Groups and Schools

Current Faculty	School			Research Themes: SNS Faculty		
	SNS	**SoE**	**SSHA**	**Global Change**	**Bio-complexity Evolution**	**Climate, Water-sheds**
ES	7	9	1	AA, MD, LK	AA, MD, BD, MM	LK, PO, ST
QSB	17	5		AA, MD	AA, MB, MD, BD, MM, JR	

* SNS Faculty: AA: Andres Aguilar; MB: Miriam Barlow; MD: Michael Dawson; BD: Benoît Dayrat; LK: Lara Kueppers MM: Monica Medina; PO: Peggy O'Day[†]; JR: Jason Raymond; ST: Sam Traina[†] (0% FTE); [†]denotes tenured faculty. Faculty contributing from SE and SSHA not listed.

b. Integrative and Evolutionary Biology

Biocomplexity and Evolution **-** Biocomplexity research explores the emergence of self-organized, complex behaviors or structures from the interaction of many simple agents in the environment. Such emergent complexity is a hallmark of life, from the organization of molecules into cellular machinery, through the organization of cells into tissues, to the organization of individuals into communities. The study of biocomplexity in the environment requires novel approaches to understanding pattern and process across multiple temporal and spatial scales, and draws upon interdisciplinary efforts at the interface of biology, physics, chemistry, and mathematics. Biocomplexity in the Environment research is a Priority Area at the National Science Foundation, with over $35,000,000 currently allocated in grant funds for 2007. Additional potential funding sources in biocomplexity research include the National Institute of Health, the Department of Energy, NASA, the James S. McDonnell Foundation, and the Moore Foundation. Biocomplexity research at UC Merced addresses a diverse range of questions relevant to integrative biology such as: What are the forces that shape the magnitude and diversity of life across multiple temporal and spatial scales? How do systems with living components respond and adapt to stress? Are adaptation and change predictable? How do organisms within and between populations interact and evolve? A core group of faculty in this research theme is developing at UC Merced (see Table E5) that is represented strongly in the QSB graduate group, and priorities in this area overlap with the other research themes in ES and QSB. To adequately develop strength in this theme and to fulfill undergraduate and graduate teaching will require further expertise in plant biology and ecology. Future positions in evolution of development, comparative evolutionary physiology, and paleoecology would solidify research in this area (Table E6).

Table E6: Proposed SNS and Cross-Unit Faculty in Environmental Sciences and Integrative and Evolutionary Biology

Faculty	Research Themes			
	Climate, Water-sheds	Global Change	Bio-complexity Evolution	Fills coursework gaps*
AY 2007-2008				
Ecology† (3 positions: microbial, biodiversity, general)	x	x	x	BIS, ESS, ES, QSB
AY 2008-2009				
Earth surface processes/ecohydrology	x	x		ESS, ENVE, MGMT, ES
Plant biology/ecology	x		x	BIS, ESS, ES, QSB
Environmental microbiology¶	x	x	x	BIS, ESS, ENVE, ES, QSB
Resource conservation and management++	x	x		MGMT, ESS, ES
AY 2009 and beyond				
Soil biogeochemist	x	x		ESS, ENVE, ES
Conservation biology	x	x		ESS, ES, MGMT
Paleobiology/ecology		x	x	BIS, ESS, ES, QSB
Comparative evolutionary physiology			x	BIS, QSB
Evolution of development			x	BIS, QSB
Deep ocean sediments			x	BIS, ESS, ENVE, ES
Physical/chemical oceanographer		x	x	ESS, ES

†Search in progress, up to two senior positions may be appointed.
¶May be cross-unit position with Engineering; may also contribute to Environmental Health Sciences.
++Cross-unit position in Management in this area is supported by EES faculty.
*BIS: Biological sciences; ESS: Earth systems science; ENVE: Environmental engineering; ES: Environmental systems; MGMT: Management; QSB: Quantitative systems biology.

c. Environmental Health Sciences

Earth is an ecosystem that houses more than one million different species whose complex interactions with each other and the environment shape the life and fate of its individual constituents and their progeny. These interactions are frequently manifest in symbiotic, parasitic and, pathogenic relationships between species. Humans frequently degrade the environment, and this in turn affects their health and safety. The cost burden for health care associated with environmental toxins and infectious agents, the emergence of drug resistant pathogens, the economic impacts of pathogens on agriculture, the threat of bioterrorism, and the increasing need to ensure clean and safe air and water are some of the compelling examples of how fundamental research in *Environmental Health Sciences* directly connects to social, economic, and political impacts both locally and globally. UC Merced is uniquely positioned to develop a strong and interdisciplinary research program in *Environmental Health Sciences*, initially focused in two highly complementary areas: *Atmospheric Pollution and Health*, and the *Ecology of Infectious Disease*. UCM Faculty who are interested in this research focus or already engaged in this research, are listed in Table E7. Potential partners outside of UCM include biologists, geochemists, and biodefense researchers at LLNL, LBNL, and Los Alamos National Laboratory and UC-wide programs in toxicology.

Table E7: Current faculty FTEs who would contribute to the development of research in Environmental Health Sciences.

Current Faculty	School			Research Themes	
	SNS	**SoE**	**SSHA**	**Atmospheric Aerosols & Health**	**Ecology of Infectious Disease**
ES	4	3	1	TW, YC, LK, VL, PO, WR	YC, AA, MD
QSB	7			HF, RO	AA, MB, MD, JC, DO

Faculty: AA: Andres Aguilar; MB: Miriam Barlow; YC: Yihsu Chen; JC: Jinah Choi; MD: Michael Dawson; HF: Henry Forman[†]; QG: Qinghua Guo; LK: Lara Kueppers; VL: Valerie Leppert[†]; PO: Peggy O'Day[†]; DO: David Ojcius[†]; RO: Rudy Ortiz; WR: Wolfgang Rogge[†]; TW: Tony Westerling. [†]denotes tenured faculty.

The Environmental Health Sciences program is unique in that it steps beyond a traditional biomedical and public health focus to examine fundamental, mechanistic questions from multiple angles, fully integrating genomic, biological, geochemical, physical, computational, and ecological tools into studies of toxins and pathogens that involve humans as well as other organisms. This initiative encompasses both research and education that intersects all three schools in a compelling interdisciplinary area and is expected to support new and existing undergraduate and graduate programs. It also complements existing and future SNS research areas in addition to the environmental research described above, including areas of Applied Math, Complex Disease States, and Microbiology and Immunology. The addition of faculty in relevant aspects of health management and policy through SSHA and/or the School of Management will

contribute to the future development of a community-health-focused medical school. Recommendations for FTE's are given in Table E8

Atmospheric Pollution and Health - Air pollution in the Central Valley is a daily burden on human and ecosystem health and well-being. 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. Two new air pollution hires (Wolfgang Rogge and a junior position in progress, both in SE) have added strength in measurement and analysis of atmospheric pollutants, and will contribute to research on human and ecological exposure. Strength in this research area can be built through the addition of FTE's in environmental toxicology, environmental epidemiology, and environmental microbiology, which will add to current expertise in pathophysiology (HF, RO), particle and surface chemistry (VL, PO), and land use-atmosphere interactions (LK) (Table E7). UC Merced is well poised to conduct critically needed basic research in this area, as well as to developing solutions to these complex environmental and public health problems. This area would benefit from the addition of faculty in atmospheric chemistry and environmental/ecological biostatistics.

Ecology of Infectious Disease - Infectious disease agents affect all living organisms, can have complex life histories involving multiple species, and can be specialists or generalists in terms of host preference. A better understanding of the ecological and socio-ecological determinants of transmission by vectors (e.g., insects, rodents, birds) or abiotic agents (e.g., dust, water, weather systems), the population dynamics of reservoir species, the transmission to humans or other hosts, or the cultural, social, behavioral, and economic dimensions of disease communication is needed. The interface between humans and both domestic and wild animals is a region rife with opportunity for emerging diseases – those that were not pathogenic in the original host, but are in the new host (e.g., Hantavirus, SARS). Evolution of infectious agents and their plant and animal hosts is also a critical component of research for understanding the ecology of infectious disease. UC Merced is uniquely positioned for research in this area, literally located in the transition zone between suburban, agricultural and natural ecosystems. Migratory birds use Central Valley agricultural fields as stopover points, and human migration supports the agricultural industry. Air pollution can make stressed organisms more susceptible to infection. Building strength in this research area requires the addition of FTE's in environmental toxicology, environmental microbiology, emerging zoonoses/immunology, and environmental/ecological biostatistics (Table E4) to complement initial expertise in evolution (MB, MD), cell level host-pathogen

interactions (JC, DO), environmental epidemiology (YC), and population genetics (AA).

Table E8: Proposed SNS and cross-unit faculty in Environmental Health Sciences

Faculty	Research Themes		
	Atmospheric Aerosols & Health	Ecology of Infectious Disease	Fills coursework gaps*
AY 2007-2008			
Mechanisms of Complex Disease†	x	x	BIS, QSB
Air Pollution (SE)††	x		ENVE, ES
AY 2008-2009			
Environmental Toxicology	x	x	BIS, BIOCHEM, ESS, ES
Environmental Epidemiology	x	x	BIS, ESS, ES
Environmental Health Policy++	x		BIS, ESS, MGMT, ES
AY 2009 and beyond			
Atmospheric Chemistry	x		CHEM, ESS, ENVE, ES
Environmental/Ecological Biostatistician	x	x	ESS, MATH, BIS, ES
Emerging Zoonoses/Immunology		x	BIS, QSB
Eukaryotic Microbiology		x	BIS, ESS, ES, QSB

† Senior searches underway – outcomes may support research in this program area
†† Junior position in negotiation stage – may support research in this program area
++Cross-unit position in SSHA and/or Management in this area is supported by EES faculty.
* BIS: Biological sciences; CHEM: Chemistry; ESS: Earth systems science; ENVE: Environmental engineering; ES: Environmental systems; MATH: Mathematics; QSB: Quantitative systems biology.

Teaching - Faculty in Environmental Sciences, Integrative and Evolutionary Biology, and Environmental Health Sciences Contributions to Undergraduate and Graduate Programs.

Undergraduate Programs: SNS faculty members with interests in environmentally related research contribute primarily to undergraduate Biological Sciences (BIS) and Earth Systems Science (ESS) majors. A number of SNS faculty with interests in *Biocomplexity and Evolution* form the core of the Integrative Biology (IB) emphasis in

BIS, whereas SNS faculty shown in table E8 (previous page), together with faculty from other schools, contribute to the ESS major. SNS Faculty indicated above contribute to other tracks in the current BIS major and to the Chemical Sciences major, particularly Biochemistry and Environmental Chemistry. Faculty contributions to multiple undergraduate majors is a strength for the school and valued by the faculty involved. However, faculty should be vested in the undergraduate majors to which they contribute.

Discussions are in progress regarding the feasibility of changing the ESS major to a cross-school major to enable faculty who teach the courses to have full participation in programmatic direction and student mentoring. This change would also enable the formulation of undergraduate tracks, minors, or new majors that intersect with Social Sciences and Management, with potential increases in student participation. Plans are in development for a separate Integrative Biology major, to be implemented when sufficient faculty are on-board to support the major. We foresee the diverse faculty who contribute to environmental research as those who will continue to contribute to a number of undergraduate majors in the future, rather than aligning strictly with a single major. From a student viewpoint, however, it is advantageous to clearly define the differences between majors such as ESS and IB when the programs share courses and faculty. Evolution of these majors will include discussion and revisions to distinguish program content and educational objectives for the student. The faculty lines proposed above will contribute to existing undergraduate programs by filling programmatic course needs and assembling a critical mass of faculty to deliver the curriculum. Furthermore, additional of faculty in the *Environmental Health Sciences* will contribute to proposed development of undergraduate programs in Biochemistry and Microbiology and Immunology, as well as supporting current majors.

Graduate Programs: At the graduate level, the environmental faculty contribute primarily to the Environmental Systems (ES) and Quantitative and Systems Biology (QSB) graduate programs, currently the two largest and most successful graduate groups. For example, current extramural grants by members of the ES graduate group/SNRI faculty have brought more than $15M in research funds and equipment to UCM between 2003 and 2010. The proposed FTE's will contribute to strategic areas within the current graduate groups, as well as contribute to development of programmatic areas that may eventually spin-off to form new graduate groups.

Resources - Development of a stellar program in Environmental Sciences, Integrative and Evolutionary Biology, and Environmental Health Sciences requires resources in faculty, space and centralized core research facilities.

Faculty: A description of the types and proposed sequencing of faculty hires for each emphasis area is described above**.** The faculty hiring plan is derived from the need for balanced growth among the thematic areas described above, graduate and undergraduate teaching demands, and identification of cross-school and cross-discipline hires that support multiple degree programs and research areas. As noted above, the interdisciplinary nature of environmental programmatic areas requires

support from a breadth of faculty within SNS and among all of UCM's schools. The research initiatives we are pursuing and the graduate and undergraduate degree programs associated with them span from "Natural Sciences-centric" to truly cross-school. Thus, long-range planning requires a university-wide view of programmatic development and needs. An immediate goal is to insure balance between SNS, SE, and SSHA/Management in thematic areas where complementary or cross-school hires can be made. We note, however, the difficulties associated with formal joint appointments for Assistant-level faculty. Given the likelihood of future junior faculty with cross-school research and teaching affinities, an explicit policy for evaluating and promoting interdisciplinary scholars should be established at UCM. Additional research support comes from the affiliation of adjunct researchers. There are presently two adjunct faculty (Duffy, Quinn) affiliated with the ES graduate group. Four additional government scientists have expressed interest in being involved with supervising graduate students, teaching, or being Co-PI's on grants. We expect to affiliate at least two more government scientists with the ES graduate group in the near future.

***Space and centralized facilities*:** The research encompassed within three broad environmental areas described above has prime opportunities for funding from a variety of government and foundation sources that span across physical, chemical, and biological sciences and engineering. Our strategic development is targeted to interdisciplinary areas where funding opportunities exist or are anticipated to increase. Programmatic growth relies on the availability of adequate space for research, graduate students, post-doctoral associates, and technical support staff for new and existing faculty as their individual research portfolios grow.

- Centralized instrumentation and computing facilities are critical to the success of the interdisciplinary research carried out in the area. Space and technical personnel support must be provided for these facilities to enable cutting edge research in a cost-effective way. Continued support for courses with field labs (which incur comparable or lower per student costs than courses with indoor labs) is critical for providing students with quality hands on research and educational opportunities.

  Several established centralized facilities figure prominently in the environmental program areas. The SNRI Wawona Field Station provides support for field-based research and learning across all research themes by housing field researchers, and by hosting field classes and workshops. SNRI is helping spearhead UCM's flagship Yosemite Leadership Program -- a partnership between the University of California, the National Park, and the largest privately owned business to develop tomorrow's thoughtful, ethical, and innovative leaders. The Environmental Analytical Laboratory (EAL, administered under SNRI) provides core analytical support for all research themes, including instrumentation for lab courses required in several majors (ESS, ENVE, CHEM). Likewise, the Imaging and Microscopy Facility (IMF) is a key support laboratory for multiple research themes and is used in several lab-based courses. The Genomic Core Facility (GCF) is the first

centralized facility with genomics instrumentation to fulfill multiple needs of faculty in SNS and SE, with a foundation based on sequencing and microarray analysis equipment already available through faculty start-up funds. The GCF is essential for the success of research themes in Global Change, Biocomplexity and Evolution, and Ecology of Infectious Diseases. A collaborative scientific supercomputing cluster is under development using start-up funds, to be co-administered by Applied Mathematical Sciences and Environmental Systems faculty with support from the School of Natural Sciences. This computing facility will support research in the Climate and Watershed Resources and Global Change research themes. Core facilities in other program areas such as those supporting chemical sciences would also be used by environmental faculty. A critical need for strengthening the Global Change and Biocomplexity and Evolution themes is a modern greenhouse facility and freshwater and seawater aquaria.

There is an immediate need to address on-campus space needs of the EAL and the IMF, or they will not be utilized to their full potential and will fail to garner sufficient recharge funds to partially support their operation. The existing centralized facilities rely on a combination of NSF-funded grants and University support to deliver cost-effective services enabling research and graduate and undergraduate instruction. University technical staff support for existing and new facilities is an essential feature of centralized facility success.

- Space and Facilities - Environmentally related faculty require a range of resources to support research that may encompass laboratory, field, and/or computational methods. Both junior and senior faculty will need adequate start-up packages, laboratory and office space, and institutional investment for equipment, both shared as noted above and individual. Each of the new faculty will require at least the CPEC average of ~700 square ft (assuming about 50% senior faculty), in addition to adequate space for centralized facilities that these faculty might use. With the possible exception of an epidemiologist or ecological biostatistician, new Environmental Health Sciences faculty require standard wet lab space with fume hoods, analytical instrumentation, and/or field equipment. New faculty in atmospheric chemistry and toxicology would likely take advantage of the Environmental Analytical Facility, and also the Imaging and Microscopy Facility or the Genomics Core lab, depending on their particular research. Depending on their research emphases, the Environmental Toxicologist, Emerging Zoonoses, and/or Animal Responses to Air Pollution researchers may need access to the vivarium or a biosafety level three (BSL3) facility (unless certain agents are avoided). Environmental Health Sciences faculty could also make use of core facilities under development by current QSB, ES, Applied Math, and Chemistry faculty.

5. PHYSICS

Overview - Physics is the study of the properties of nature at their most fundamental. It ranges from the study of the very tiniest pieces of matter and energy, including molecules, atoms, photons, and subatomic particles, to the study of the entire universe. Insights in physics have revolutionized our society. It is hard to imagine an area of science or engineering that has not been profoundly affected by fundamental developments in physics. One need only think of the harnessing of electricity, the invention of the transistor, and the discovery of the laser. The present strength in physics at Merced is centered on three broad areas of research, detailed below.

Research -

a. Atomic, Molecular, and Optical Physics

UC Merced is building a strong research emphasis in atomic, molecular, and optical (AMO) physics. Interest and developments in this field have surged in the last ten to fifteen years, primarily due to advanced experimental techniques. These developments have been recognized by several recent Nobel prizes: for ion trapping and atomic clocks (1989; Ramsey, Dehmelt, Paul), for atomic cooling and trapping techniques (1997; Chu, Cohen-Tannoudji, Phillips), for the creation of Bose-Einstein condensates (2001; Cornell, Ketterle, Wieman), and most recently for advances in quantum optics (2005; Glauber, Hall, Haensch).

The modern trend in AMO science is toward greater control over quantum systems such that quantum coherence is maintained and quantum processes can be resolved. This includes working at very low temperatures, at ultrashort time scales, and with very high spectroscopic precision. Modern techniques can now routinely address single atoms, single photons, and single qubits (the quantum analog of a bit).The technological implications for such precise control over the fundamental building blocks of ordinary matter are as yet unimagined, but the promise is great. By analogy, the laser, which in some sense is a “Bose-Einstein” condensate of photons, has impacted almost every area of technology and medicine. The program in AMO physics complements the research programs in condensed matter physics and chemistry.

At present UC Merced has hired five faculty whose research supports the general AMO theme: Roland Winston and Ray Chiao (both split between Natural Science and Engineering), Kevin Mitchell, Jay Sharping, and Sayantani Ghosh. A search is currently being conducted this year for one additional junior faculty position in AMO physics. Potential areas for subsequent AMO hires, include, but are not limited to:

- *Ultrafast Optics*: pico-, femto-, and attosecond pulses, time-domain studies, wavepacket dynamics, high harmonic generation, photonic crystals and nanostructures for plasmonics and terahertz dynamics
- *Attosecond Physics*: fourth generation synchrotron sources, attosecond pulse generation, characterization, and applications
- *Fundamental Quantum Processes and Engineering*: quantum control, quantum computing and information theory

- *Atomic Cooling and Trapping*: ultracold gases and plasmas, Bose-Einstein condensates, degenerate Fermi gases, superfluidity
- *Precision Measurement*: atomic clocks, ultrasensitive detectors, high precision spectroscopy, multi-photon microscopy
- *Novel Imaging Techniques*: sub-diffraction fluorescence imaging, near-field imaging, etc.

Funding potential: Various government funding agencies support physics research, and AMO research in particular, with NSF being the largest sponsor of table-top AMO research. Furthermore, DOE funds several large national user facilities, including three that are strategically located with respect to UC Merced: Lawrence Livermore National Lab, Lawrence Berkeley National Lab, and the Stanford Linear Accelerator Center. In addition, optics research has historically benefited financially from its close connection to industry and industrial applications.

Cross-Disciplinary and Cross-School Linkages Expertise in AMO science has a natural connection to other present and potential University research programs. This is reflected in the fact that two of the AMO faculty have joint appointments between natural science and engineering. Specific connections include, but are not limited to:

1. The energy sciences program: Optics is of fundamental importance to solar energy collection.
2. Chemical physics/ physical chemistry: Current faculty rely heavily on lasers and other optical techniques. They could be well supported by additional expertise in optics and atomic physics.
3. The materials or nanoscience programs would benefit from advanced optical techniques. Also, many of the issues of quantum control, manipulation, computing, etc. are relevant to nanoscience just as they are to AMO science.
4. Computer science: Quantum computation and information processing synergizes naturally with computer science.
5. Biology and Earth systems science: Synergy could potentially arise in the areas of microscopy, advanced detector design, and optics.

b. Condensed Matter Physics

The Condensed Matter Physics program in Natural Science is a broad, interdisciplinary program focusing on "condensed" phases of matter. These phases range from simple solids and liquids to metallic and semiconductor nanomaterials to exotic condensed phases such as the superconducting phase exhibited by conduction electrons in certain materials, and the ferromagnetic and antiferromagnetic phases of spins on atomic lattices. The intellectual scope of this program is vast, and includes an understanding of the optical, electrical, mechanical, and transport properties of materials, encompassing the nano- to the macro-scale. Research in condensed matter can be harnessed to design new materials such as magnets, semiconductors, ferroelectrics, superconductors, polymers, and liquid crystals, used for applications in a wide variety

of disciplines including efficient energy conversion, ultra-fast optics, quantum information processing, and structural materials, to name a few.

The faculty participating in this program spans the disciplines of solid state physics, nanoscale physics, soft matter physics, physical chemistry, surface science and materials characterization. Several specific areas that are at the forefront of modern condensed matter science are targeted. These include photonic materials, nano-scale electronics, quantum information and "smart" materials.

Photonic materials - "Photonics" may be broadly defined as the technology of generating and harnessing light and other forms of radiant energy. All photonic technologies rely on appropriate materials, which may be organic, inorganic, or composites. Materials that respond nonlinearly to light are used in frequency conversion of lasers, as optical limiting materials to protect eyes or optical sensors from laser pulses, and as contrast agents in nonlinear optical imaging technologies. Materials that change their optical properties in response to applied electric fields can be used to fabricate electro-optic modulators for electrical to optical conversion in fiber-optic communications. Photonic band-gap crystals, periodic dielectric structures that forbid propagation of a certain frequency range of light, have potential applications in ultra-low-threshold lasers, optical filters, polarizers, and waveguides. Metamaterials are those that exhibit novel optical properties leading to compact imaging systems and even "cloaking" devices. Research in this area is highly interdisciplinary and spans solid-state physics, surface science, optical physics, physical chemistry and applied mathematics.

Nanoscale electronics - " Nano-electronics" is poised to provide the next technological revolution in computer design. Moore's prediction of rapid miniaturization has already pushed commercial transistors well below 100 nm in size. Developing an in-depth understanding of the fundamental properties of nanoelectronic devices is of crucial importance because Nature behaves quite differently at the nanoscale, and an extrapolation of our knowledge at larger dimensions is not possible. It is not prudent to invest a vast amount of time and effort to try to compete with the immense silicon industry. Instead, it is more attractive to look into nanoelectronic devices that could play a role complementary to the silicon technology, with a strong focus on exploring the possibilities of organic materials, for example in the form of single molecules or self-assembled molecular monolayers. Investigating the use of complex transition-metal oxides in nanoelectronic devices is another field worth exploring since these materials show a wide range of interesting characteristics, including strongly insulating behaviour, high-temperature magnetism and superconductivity. Nanoelectronics is the field where physics, material science, chemistry and electrical engineering inevitably meet.

Quantum information science - The tremendous miniaturization of electronic devices has led to the point where the spatial scale has hit the atomic limit. In this regime, the quantum properties of matter dominate, which, at first glance, seems to compromise information processing and storage, since quantum states are unstable and are

destroyed by the very act of making a measurement. However, this very fragility of quantum phenomena has the capability of revolutionizing the fields communication and computation. A quantum channel of information transfer is very secure, since any effort to eavesdrop leaves an imprint on the quantum state. Computation power is exponentially enhanced when using quantum bits instead of classical ones due to the property of entanglement, which adds immense parallel processing capabilities. Recently, quantum information processing has started influencing the agenda of condensed matter, and some of the implementable quantum bits which this field has contributed include superconducting structures (Josephson junctions), single-electron quantum dots and semiconductor photonic devices.

Photovoltaics - As the worldwide demand for energy increases, the need for renewable energy sources will become more and more urgent. Solar energy is the obvious answer, providing an unlimited, pollution-free energy source. Through the use of efficient photovoltaics, a relatively small amount of land area can in principle be used to meet the energy needs of the entire United States. For these reasons, research into more efficient and lower cost ways of turning the energy of sunlight directly into electrical energy is now, and will continue to be, an important field in the physical sciences. Photovoltaic devices can be grouped into two broad categories, each type having its advantages and disadvantages: solid state (semiconductor) devices, which may be organic, inorganic, or hybrid, and electrochemical cells.

The areas described above are particularly attractive because they offer the possibility of many different types of collaborations, both within UC Merced and at other nearby institutions. Potential industrial collaborators include Hewlett-Packard's basic research labs in Palo Alto. There are also collaborative opportunities with LLNL through LLNL/UCM adjunct faculty. We also anticipate that collaborations and funding through NASA/Ames will be available in the near future.

Current faculty in this research area include: Sayantani Ghosh (experimental condensed matter physics), Raymond Chiao (experimental condensed matter physics), Ajay Gopinathan (theoretical soft condensed matter physics).

Other faculty across disciplines who could contribute include: Roland Winston (solar energy, optics), David Kelley (experimental chemical physics), Anne Kelley (experimental physical/analytical chemistry), Jennifer Lu (materials engineering), Valerie Leppert (materials engineering).

Given the necessarily diverse and fundamentally interdisciplinary nature of this group, and the desirability of building on and extending current strengths, we would like to see recruitment of new faculty in fields that encompass and bridge condensed matter physics, physical chemistry, and materials engineering. We need to recruit faculty with related but complementary research interests in order to build a program that can attract graduate students, offer modern and compelling programs for both undergraduate and graduate students, successfully compete for funding, and achieve national and international prominence in research. Several searches underway during

the current academic year may result in new faculty who would contribute to this research area: Condensed matter physics (Assistant Professor), Nanoscale Physics (Senior). It is assumed that these positions will be carried forward if we are unsuccessful at filling them this year.

Funding potential: The level of support available is a primary concern when considering programmatic initiatives. This type of research is very well funded and we suspect will continue to be well funded in the foreseeable future. The Bush administration's American Competitiveness Initiative (ACI) commits to doubling, over 10 years, funding for research at key federal agencies that support physical science and engineering: NSF, DOE's Office of Science, and NIST. Part of the ACI is the Advanced Energy Initiative, which provides for a 22% increase in funding for clean-energy research at the DOE. The fields of solid-state physics, and materials science will be key to advances in new energy sources, and UCM could become a major player in a field in which few established universities yet have large, well developed programs.

Single-investigator or small collaborative group funding in this field is available from a number of different agencies and programs within these agencies. The following programs are now (October, 2006) soliciting proposals in Condensed Matter Physics and Materials Science:

- NSF: programs in Physics and Materials Research divisions.
- AFOSR Broad Area Announcement (BAA): programs in Metallic Materials, Ceramic and Nonmetallic Materials, Quantum Electronic Solids, Semiconductor Materials, Surface and Interfacial Science.
- ARO BAA: programs in Condensed Matter Physics, Quantum Information Science, Surfaces and Catalysis, Electrochemistry and Advanced Energy Conversion, Materials Synthesis and Processing.
- ONR BAA: programs in Electronic Materials, Semiconductor Materials.
- DARPA: solicitation in Nano-Composite Optical Ceramics.
- DOE: Several programs in Basic Energy Sciences: Condensed Matter Physics, Materials and Engineering Physics.

c. Biological Physics

Experimental, computational and theoretical methods and techniques from Physics have played a major part in recent advances in our understanding of biological systems. Examples include cutting-edge imaging techniques that have provided snapshots of biological molecules and their complex assemblies in action and have also led to dramatic improvements in medical imaging. The ability to control matter at the smallest scales, using for example optical and magnetic tweezers, has allowed us to study and manipulate biological processes at the single molecule level. Theoretical and computational modeling are leading the way in our efforts to understand protein folding/misfolding, the functioning of molecular motors and enzymes, ion channels, membrane structure and dynamics as well as the dynamics of complex biochemical and neural networks. The result of advances in biological physics will be a better

understanding of normal and pathological processes at both the molecular and systems level. Equally important, from a physics perspective, is that studies of biological systems that serve as paradigms of complex, self-assembling, non-equilibrium systems has led to new and interesting physics including emergent properties in dynamical networks, self-assembled, self-replicating systems, the thermodynamics of "active" systems and an atomistic understanding of complex macromolecules. Biophysics for its part is the most rapidly growing area in physics research attracting both seasoned physicists from several different subfields and large numbers of entering students

To develop a state of the art research program in biophysics requires individuals who have had extensive training in doing biophysical research, hailing from either traditional physics subfields such as condensed matter, polymer or statistical physics or from more interdisciplinary backgrounds including specifically biophysics, materials or bioengineering.

The SNS faculty at UC Merced who work directly in areas of biophysics are Mike Colvin, Ajay Gopinathan and Tao Ye. Others including Jinah Choi, Henry Forman, Anne Kelley, Michelle Khine, Andy LiWang, Patti LiWang, Matt Meyer, Alexandre Noy, Jay Sharping and Christopher Viney can contribute to this area.

A core group of at least six biophysicists is needed to establish a strong competitive program. Broad areas of interest include biomaterials and biopolymers, membranes and associated phenomena, single cell studies of biomechanics including motility and mitosis, microfluidics with biological applications and protein folding. Several specific research fields are listed below that would allow us to attract the best available candidates with interests in these broad areas.

- Biocompatible organic materials as organ replacements and/or as scaffolds for cell growth (links to Materials program and to Bioengineering)
- Development of ultrasensitive bioanalytical techniques, particularly for single molecule/single assembly measurements and/or high throughput screening
- Single molecule studies of molecular motors, DNA/RNA dynamics, transcription factor binding/functioning, viral genome packaging, ion channel transport etc.
- DNA and/or other biological macromolecules as scaffolds for fabrication of organized structures (links to Materials program)
- Protein folding, experimental and computational methods that quantitatively determine protein structure and folding pathways
- Atomistic modeling of biological systems: channels, membranes, receptors, proteins, enzymes (links to CCB)
- System level studies of mitosis, morphogenesis, cellular motility, cytoskeletal dynamics, viral self-assembly, cellular hydrodynamics, chemotaxis and pattern formation. (links to Systems Biology)
- Membranes and associated phenomena including fusion, exo/endocytosis, pore formation and functioning, lipid rafts. Also biomedical applications of engineered membranes. (links to Materials and Bioengineering).

It is to be noted that many of these areas will have a considerable overlap with research interests in Biochemistry and Molecular Biology. We anticipate hiring both theorists and experimentalists in these fields.

Funding potential: Funding for biophysics is growing at an extremely rapid pace. The NSF provides substantial funding for fundamental research in physics including its interfacial areas with biology. Research more directed toward specific problems in the life sciences is supported by the NIH, and also to a significant extent by the DOE and defense organizations (ONR, AFOSR, ARO). Funding for research in biological physics is also available from private foundations (*e.g*. Packard, Hughes, Burroughs-Wellcome) and for-profit companies. Faculty with research interests in this area should have a variety of funding opportunities available to them, although all of these sources are highly competitive.

*Cross-disciplinary and cross-school linkages**:*** The fundamental principles of Physics form the foundation for all of modern science and engineering. While there remain exciting unsolved problems in pure physics there is increasing interest in the frontiers that lie at the intersection with other disciplines including the life sciences, earth and environmental sciences, and engineering. The Biological Physics program is explicitly interdisciplinary between the physical and life sciences, and there should be extensive opportunities for collaboration across these groups. In particular, Biological Physics faculty are expected to have research interests that overlap Biochemistry, Molecular Biology and engineering, particularly Bioengineering. Finally, this research area offers a natural interface with the proposed medical school. Interdisciplinary collaborative science is one of the strengths that UC Merced can leverage as a research institution, and this strength should be fostered as a means of bolstering the resources and potential of both biological and physical science at UC Merced.

Resources - Development of a world class inter-disciplinary physics program requires faculty, space and access to core facilities.

Faculty: At a bare minimum twelve FTEs will be needed to teach the core of the undergraduate and graduate physics curriculum, with more faculty needed to provide depth in our course offerings and to provide a critical mass for an effective research environment. This implies a hiring rate of at least two faculty per year. We currently have five FTEs dedicated to teaching physics (Profs. Chiao and Winston at 1/2 FTE each and Profs. Mitchell, Ghosh, Gopinathan, and Sharping at 1 FTE each.)

Table E9: Summary of Proposed Physics Faculty Hires for the Next Five Years

Faculty	2007-2008	2008-2009	2010-2011	2011-2012	2012-2013	2013-2014
Current	5	9	11	13	15	17
Active searches	4	2	2	2	2	2
Cumulative	9	11	13	15	17	19

Space and Shared Facilities: We expect about a three to one ratio between experimental physicists and theoretical physicists. Thus, most physics hires will be experimentalists. Although the nature and configuration of the space required by different types of physicists are quite different, all of the experimentalists are likely to require an average of at least 1000 sq. ft. of lab space each, plus office space for the PI, postdoctoral fellows, and graduate students. Established senior faculty will require more space than this. Start-up costs for experimentalists depend on specific research needs but typically fall in the $400,000-$750,000 range.

Experimental condensed matter and AMO physicists sometimes need bench and fume hood space, but typically have large pieces of specialized equipment such as cryostats, vacuum chambers, and laser-based setups on large optical tables. They often also have specialized requirements for the space in which these instruments are housed, such as high temperature stability, low vibration, isolation from sources of electrical noise, and light-tightness. Because of the specialized nature of the instrumentation it is often not possible for a single room to be shared by multiple investigators

Experimental biophysicists tend to have research groups that require a mixture of wet lab space, with fume hoods, and dry space for specialized instruments. They are less likely to rely heavily on shared core facilities, though depending on the specific field they may require access to XRD or lithography facilities.

Theoretical and computational hires will require office space and computational facilities for the PI, postdoctoral fellows, and graduate students.

F. ACADEMIC PROGRAMS

The School Faculty participates in multiple graduate groups and contributes to teaching in undergraduate programs offered by the School of Natural Sciences and graduate programs in the Graduate Division. Individual faculty members can join multiple graduate groups. Current faculty members are active in Environmental Systems, Quantitative and Systems Biology, Applied Mathematics, Chemistry and Physics, Mechanical Engineering, Biological Engineering and Small Scale Devices, and

Mechanical Engineering. Strong graduate programs are essential for development of stellar research programs and graduate students are critical to serve as teaching assistants for undergraduate courses.

Table F1: Summary of Academic Degree Programs and Graduate Groups

Undergraduate Degree Programs
Applied Mathematical Sciences, B.S.
Biological Sciences, B.S.
Chemical Sciences, B.S.
Earth Systems Science, B.S.
Physics, B.S.

Graduate Group Affiliations
Chemistry and Physics, M.S./Ph.D.
Environmental Systems, M.S./Ph.D.
Quantitative Systems Biology, MS./Ph.D.
Applied Mathematics, M.S./Ph.D.

1. Undergraduate Programs

The opening of undergraduate majors to students occurred in a sequential manner. Biological Sciences, Human Biology and Earth Systems Sciences were available in 2005 followed by Chemical Sciences, Physics and Mathematical Sciences. An initial major Human Biology was integrated into the Biological Sciences major as an emphasis track in AY2006-2007. The existing majors provide attractive options for students interested in the science degree programs that are most popular at comparable UC campuses. The Faculty is considering options to open new majors, including biochemistry, integrative biology, microbiology and immunology and cell and developmental biology.

Table F2: Synopsis of Majors

Applied Mathematical Sciences	
Emphasis:	Computational Biology
	Economics
	Physics
Biological Sciences	
Emphasis:	Human Biology
	Integrative Biology
	Molecular and Cell Biology
Chemical Sciences	
Emphasis:	Biological Chemistry
	Environmental Chemistry
	Materials Chemistry
Earth Systems Sciences	

Emphasis:	Atmospheric Sciences Ecosystem Sciences Geochemistry and Biogeochemistry Hydrologic and Climate Sciences
Physics	
Emphasis:	Atomic/Molecular/Optical Physics Biophysics Earth and Environmental Physics Mathematical Physics

The distribution of students in SNS majors is shown below (Table F3).

Table F3: Natural Sciences Declared Majors in AY 2005 - 2007

Majors	AY 2005-2006[a]	AY 2006-2007[b]	AY 2007-2008
Applied Mathematical Sciences[c]	-	6	23
Physics[c]	-	3	15
Chemical Sciences[c]	-	6	23
Earth Systems Science	8	9	18
Biological Sciences	310	358	477
Nat Sci Undeclared	47	38	79
Total (% of campus)	365 (40%)	420 (32%)	673 (38%)

[a] Declared science majors at the 3rd week in Fall 2005 and Spring 2006
[b] Declared science majors at the 3rd week in Fall 2006
[c] Opened to freshmen in AY 2006-2007

Appendix 1 provides further detail about anticipated student demand, majors and student FTE, and faculty workload. While the lower division courses, with the exception of mathematics, are typically large classes, >100-200 students in many cases, upper division courses are expected to be considerably smaller. This will clearly be the case for majors that are small at the outset, such as chemistry, physics and mathematics. It is considerably more challenging to provide the same experience for students in large enrollment majors, such as biology. Thus, careful tracking of the success and experiences of students enrolled in upper division courses that define the majors is an important indicator of success of students and majors.

Applied Mathematical Sciences **-** Mathematics is a relatively popular major for undergraduate students. Approximately 1-3% of all undergraduates at the other UC campuses are mathematics majors. These enrollments are comparable to enrollments in other programs such as computer and information science and physical science. Among those undergraduate majors, a significant number of students are pursuing some form of applied mathematics where available. This interest is maintained because students realize their advantageous position in the job market when they have a strong foundation in

mathematics, extensive computational skills and expertise in another marketable area of study.

The applied mathematical sciences undergraduate major at UC Merced is designed to prepare students for careers in research, business and industry in a broad range of fields. This major uses a "core + emphasis" model. The core is designed to give students a rigorous learning experience in analytical and computational mathematical analysis and methods. The emphasis tracks are comprised of significant coursework in another field of study. The initial emphasis tracks are: *Physics, Computational Biology, Economics*; future emphasis tracks are: *Environmental Science and Engineering, Computer Science & Engineering, Electrical Engineering, Mechanical Engineering.*

Chemical Sciences - The Chemical Sciences major meets the requirements for approval by the American Chemical Society. Students who complete an approved curriculum may obtain a certified degree, a valuable credential which serves as national-level recognition for successfully completing a rigorous academic chemistry curriculum in an ACS-approved department. ACS accreditation may be sought upon graduation of the first majors and we anticipate accreditation in 2010. The curriculum is designed to meet the needs of students who plan to end their formal education with a bachelor's degree as well as those who wish to go on for an advanced degree. The UC Merced chemistry B.S. graduate will be well prepared to pursue a career in chemistry or an allied field. A basic chemistry program and three emphasis tracks in biological chemistry, environmental chemistry, and materials chemistry allow students to pursue interdisciplinary areas within a degree program that is still focused on chemistry.

A degree in the chemical sciences opens the door to a wide variety of careers in industry or government service, forensic chemistry in crime laboratories, commercial fields such as patent law and scientific writing, and high school science teaching. Many chemistry majors go on to graduate study to prepare for careers in teaching and/or research at the college or university level, or research positions in the chemical, pharmaceutical, electronics or other high-tech industries. A major in chemistry is also an excellent foundation for medical school or other careers in the health sciences.

Earth Systems Science - The Earth Systems Science (ESS) program was devised with an interdisciplinary core + emphasis model. Current emphasis tracks are: Atmospheric Sciences, Ecosystem Science, Geochemistry and Biogeochemistry, and Hydrologic and Climate Sciences. The ESS undergraduate degree program was formulated and is currently being supported by more ENG faculty than NS faculty (5 ENG vs. 3 NS plus two joint appointments), often through co-listed upper division ESS-ENVE courses. Because the ESS major is evolving to a true cross-school major, we propose that ESS should be formally established as a cross-school major, with potential re-formulation of the degree to be determined by the participating faculty. An exploratory committee is forming to perform the needed revisions to the major, and assure that an appropriate administrative structure is created to administer the major. We believe that with the recent and near term addition of critical faculty, and an aggressive revision and recruiting effort, ESS will be transformed into a long-term viable major at UCM. In established

universities, majors in the environmental area generally constitute about 3-5% of all undergraduates.

Biological Sciences - To-date Biological Sciences is the highest enrolled major on campus with more than 35% of undergraduate campus enrollments. UC Merced opened with two life sciences degrees: Biological Sciences B.S. and Human Biology B.A. Last year the faculty consolidated these two majors under the Biological Sciences B.S. as two core tracks –MCB and HBIO. Additionally, a third core track was established in IB; and a fourth Biochemistry/Molecular biology (BMB) emphasis requiring two years of chemistry is being elaborated.

Molecular and Cell Biology (MCB) is the most popular emphasis in Biological Sciences. A signature feature of this major is the large number of mathematics and computations courses, including mathematical biology and an emphasis on quantitative concepts in the biology core curriculum, as well as a requirement for at least one semester unit of research experience for all students. At the present time the growth of the biological sciences major is outstripping the growth of the faculty to teach the relevant core and emphasis tracks. Major goals for this coming year will be effectively to advertise other options to students, such as Earth Systems Science and the new Integrative Biology (IB) track. We anticipate that approximately 10% of the MCB students will move into the IB track

The HBIO emphasis shares cores courses and some emphases with the MCB track, but it also includes additional courses often required for health sciences professional schools. As with the MCB Core, the HBIO emphasis requires three additional thematically linked courses in topics such as human health, psychology, or environmental health.

The Biochemistry emphasis will emphasize chemical aspects of biology but will still be more biological than the similarly named biological chemistry track in the chemistry major.

The Integrative Biology emphasis provides students with a comprehensive education in all aspects of the complexity and diversity of life. IB is presented as a multidisciplinary science involving a wide range of complementary disciplines and contributes to, and benefits from, MCB & HBIO as well as ESS but also has its own unique organismal emphasis. This track is unique because it integrates multiple perspectives across the levels of life's hierarchy that extend from molecules to ecosystems.

Physics - Due to its foundational and applied importance, physics is an integral part of any general science program. The physics program at UC Merced is educating students in the basic physical properties of the natural world, and how these properties are manifest in a wide array of scientific phenomena. Physics students learn how to reduce complex problems to essential core issues, with an emphasis on quantitative and analytical reasoning. This broad range of fundamental skills is excellent training for a wide range of technical and/or analytical careers in the industrial sector, as well as for further graduate education in physics and related disciplines.

The physics major at UC Merced is distinguished from traditional programs by consisting of a core physics curriculum together with a student selected emphasis track. This is consistent with the other majors in the School of Natural Sciences. The proposed tracks include atomic/ molecular/optical (AMO) physics, mathematical physics, biophysics, and earth/environmental physics. Students may also design their own tracks with the assistance of their faculty adviser. The track structure allows students to explore physics within a variety of contexts, and it helps to build synergy between physics and the other scientific disciplines at UC Merced.

Minors - The SNS has developed minors to encourage students to increase their content knowledge breadth and to provide opportunities to develop additional depth in areas outside their major. Minors are available in physics, mathematics and natural sciences education (NSED). The NSED minor provides math, science and engineering students who are considering a teaching career courses in best practices of science-math teaching, and field experiences in K-12. The minor was designed so that courses articulate with those required by the state of California to become a credentialed teacher, facilitating student entry into credentialing programs and reducing the time post baccalaureate to receive a teaching credential. The students are also eligible to become an intern teacher after graduation, which allows them to be compensated during the credentialing process. This minor is part of the Science Math Initiative (see below).

Metrics for Success of Undergraduate Programs and Majors - One indicator of success for an undergraduate major is the number of students enrolled in upper division courses and the number of graduates from each major. Some majors, such as biology, have inherently high enrollments compared to mathematics, physics, chemistry and earth systems science majors. This is particularly problematic for the School, which strives to have an equitable workload policy (Appendix 2), because the School needs to balance faculty workloads, while encouraging success of all of the academic programs to which it has committed. Thus, it is important that School be realistic about taking on new programs if it is unable to meet the needs of existing programs. While the absolute number of students enrolled in upper division courses is important for faculty workload equity and instructional planning, the rate of increase of students in these courses over time can be used as an early indicator of success, particularly as the campus enrollments continue to increase. Steady growth of student enrollments in upper division courses and numbers of graduates in each major will be used to evaluate program success.

2. Graduate Programs

In fall 2006, the School Deans were given responsibility to serve as lead deans for selected graduate programs. In this role, the lead dean serves as an advocate for the graduate programs and balances resources needed for successful growth of graduate programs with resources needs for the undergraduate programs. The dean of the School of Natural Sciences serves as the lead academic dean for the graduate programs in applied mathematics, atomic and molecular science and engineering, and quantitative

systems biology. In this role, the lead dean is responsible for leveraging school and campus resources to ensure success of the graduate programs.

Table F4: Graduate Student Enrollment in Programs with Natural Science Faculty Participation

Graduate Programs	AY 2005-2006[b]	AY 2006-2007[b]	AY 2007-2008	AY 2008-2009
Applied Mathematics	-	5	9	18
CP	3	8	11	24
ES	16	19	21	25
QSB	8	14	24	48

As of 3rd week in Fall 2006

[a] Numbers based on campus enrollment report to UCOP

Resources needed for the graduate programs include sufficient faculty to deliver the graduate program, space for graduate students, and successful faculty research programs. A brief description of the graduate programs follows:

Applied Mathematics - Applied Mathematics (AM) was initiated in Fall of AY 2006-2007. This graduate group offers M.S. and Ph.D. degrees. This graduate program educate students in partial differential equations, numerical analysis and scientific computing, and asymptotic and perturbation analysis, among other special topics such as dynamical systems, computational fluid mechanics, nonlinear wave propagation, inverse problems, iterative methods, etc. Doctoral research projects are multi-disciplinary by construction and complement and contribute to the research going on in other graduate groups.

A focus of AM is to be highly interdisciplinary with contributions from faculty throughout the UC Merced campus. To facilitate this multi-disciplinary approach in manner that is flexible and inclusive, the AM faculty structure has "core" faculty and "affiliate" faculty. The core faculty is responsible for the development and support of the graduate program. Affiliate faculty members contribute by providing interdisciplinary research opportunities for graduate students thereby fostering multi-disciplinary research teams. While the current core faculty is primarily in the School of Natural Sciences, current affiliate faculty are from all three schools. Current affiliate faculty research interests include labor economics, neural networks, image processing, geometric modeling, and contaminant transport in aquatic systems, among others. Affiliate faculty members teach interdisciplinary graduate courses, advise graduate students, and/or serve on graduate committees. Through the participation of the affiliate faculty in this way, we ensure that AM builds strong linkages to other research programs on campus.

Applied mathematics at UC Merced is different from similar programs at other universities because all other applied mathematics programs are small programs or specializations within, or along side a larger "pure" mathematics program. Furthermore, the applied mathematical sciences program at UC Merced is developing along side other innovative programs rather than after all these programs are in place. The opportunity to

develop applied mathematics at UC Merced is attractive to students seeking an interdisciplinary mathematics graduate education. Because applied mathematicians are trained essentially in two or more disciplines, graduate students with that education have several options in the competitive academic job market. Moreover, the greater job market beyond academia is responding quickly and positively to graduate students with an interdisciplinary mathematics education. This graduate program, for instance, is well positioned to address growing demand in computational scientists in both industry and government research laboratories and centers.

Chemistry and Physics - Graduate students doing research in chemistry and physics at UC Merced are currently under the auspices of the Atomic and Molecular Science and Engineering emphasis area (proto-graduate group). Two second-year graduate students and four first-year students, all working with Natural Science faculty (two organic chemists, two physical chemists, and two physicists), are currently in the group, and the first of these students passed his advancement to candidacy exam in December 2006.

Graduate students in the physical sciences need to take a number of core graduate courses in order to acquire the fundamental proficiency in a discipline needed as a basis for Ph.D. level research. The group currently has a small number of approved graduate level courses geared primarily toward physical chemistry and materials engineering. Graduate level courses in organic chemistry and physics are under development. AMSE 290 (Special Topics) and AMSE 291 (Graduate Seminar) are offered every semester. AMSE 231 (Molecular Spectroscopy) was offered during Fall 2005, and AMSE 213 (Chemical Thermodynamics and Kinetics) was offered in Fall 2006. To provide a cohesive graduate program having the required disciplinary depth, we need to be able to offer about four graduate-level organic chemistry courses and at least eight physics and physical chemistry courses (in addition to AMSE 290 and 291). Each semester at least four faculty members will need to teach in the graduate program and be unavailable for undergraduate teaching. The small number of faculty in the group and the demands on the faculty for undergraduate teaching has made it difficult to accommodate the necessary graduate courses, most of which are being taught as overloads. Research-active chemistry and physics faculty at other research universities normally teach no more than one regular course, graduate or undergraduate, per term.

Because of the great disciplinary breadth spanned by the faculty, we have defined three emphasis tracks within the group: Physics, Chemistry, and Materials Science and Engineering. This organizational structure preserves the interdisciplinary flavor of the group's research interests, but it also addresses the fact that students need to develop a strong foundation in a core area of expertise before beginning scientific research. The three different tracks allow the CP group to administer tailored preliminary exams and to offer graduate courses appropriate for a student's area of expertise. At some point in the future, these three tracks will likely split into three distinct graduate groups, which nevertheless maintain their inter-disciplinary through shared research interests and goals.

None of UC Merced's current graduate groups are a fully appropriate home for faculty whose primary research interests are in Biological Chemistry and Physics. The CP group

is oriented toward materials, and while faculty who are primarily physicists, physical chemists or who have a strong biomaterials component may fit here, bioorganic chemists and biophysicists do not. Quantitative and Systems Biology may be a suitable home for the more biologically oriented members of this group, but its research programs are directed toward biology, not chemistry or physics. Most importantly, neither group is likely to be very attractive to prospective graduate students who come from a predominantly physics, organic chemistry, biochemistry, biophysics, or bioanalytical chemistry background and want a graduate program that is highly focused on biological chemistry and physics. Formation of a graduate group in Biological Chemistry and Physics would appear to be desirable once an adequate number of faculty in this area are on board. In the event of Chemistry and Physics graduate groups being formed, this group could also serve as a research pillar offering specialized courses with faculty belonging to the Physics or Chemistry graduate groups. In view of the popularity of biologically oriented chemistry and biophysics among students seeking Ph.D. degrees, it would seem foolish for us not to create structures for graduate education that will encourage such students.

Environmental Systems - Research in Evolution and Environmental Sciences is anchored by the Environmental Systems (ES) graduate program, which has been the most successful graduate program at UCM. The current census includes 7 M.S. and 15 Ph.D. students, with one masters student graduated in 2006. The ES faculty are currently split between NS, ENG, and SSHA, with several joint appointments (Table E5). The ES group (9 faculty) has already enjoyed enormous success in acquiring extramural funding in support of its research and laboratory facilities (more than $9M research funding between 2003 and 2009) and plans to continue this trajectory of extramural funding growth as the faculty expands. The ES group has already attracted strong graduate school applicants and is well poised for expansion if faculty growth is maintained. The SNRI is a key asset in building international prominence for our graduate program and facilitating high-impact interdisciplinary research. The ES faculty recognizes that the strength and uniqueness of the program lies in its position at the interface between science and engineering disciplines, and in its integration among chemical, physical, and biological Earth processes. As such, an important tenet of strategic faculty growth is to maintain a complementary balance of faculty in the Schools of Natural Sciences and Engineering, or joint positions, when appropriate, in strategic areas.

The ES group is developing plans to introduce professional M.S. programs in popular areas for individuals interested in career development (e.g., environmental systems engineering; water resources science and management; geospatial analysis; public lands conservation and management). In order to deliver this type of program while maintaining a strong Ph.D./M.S. research program and delivering undergraduate curricula, sufficient faculty will be needed in key areas to balance teaching load with research across all degrees levels. Complementary faculty associated with the School of Management will also be required to deliver this type of degree.

In addition to ES, several of the Evolution and Environmental Sciences faculty are affiliated with the Quantitative Systems Biology (QSB) graduate program; most of this faculty admit, or plan to admit graduate students through both degree programs,

depending on their students' interests. Given the dual affiliations of these faculty, several future course offerings will likely be cross-listed between the two programs, fostering interaction among QSB and ES graduate students. Several of the emerging research initiatives above may foster new graduate degree programs as they grow.

Quantitative and Systems Biology - In AY2007-2008, there are 24 graduate students in the Quantitative and Systems Biology Graduate Group (QSB), of which 9 were in the biomedical sciences. Based on the growth in QSB faculty over the past year and the concomitant growth in research funding awarded to UC Merced, we expect this number to grow steadily. Another source of growth in the biomedical sciences graduate programs will be M.S. students. There have already been many inquiries about the 5th year MS program being offered as part of the Molecular and Cell Biology emphasis track, so it may be reasonable to assume that 15-20% of the graduating Biological Sciences seniors would go on to this program.
The evidence from existing programs is that UC Merced has the opportunity to create a substantial graduate program in the biological sciences. Nationwide, the pool of biology doctoral students is very large. In 2002 nearly 4,500 life sciences Ph.D.s were conferred—by comparison in the same year 3,800 were conferred in all of the physical sciences combined. [http://nces.ed.gov/programs/digest/d03/tables/dt254.asp] Moreover, life sciences doctoral programs have a strong record of successfully recruiting women—approximately 45% of life sciences Ph.D.s went to women in 2002, compared with 28% in the physical sciences and 17% in engineering. [http://www.bls.gov/emp/mlrtab2.pdf]. The large number of biology Ph.D.s is driven by the large size of the biology research community. The US Department of Labor reports a labor pool of 75,000 life scientists in 2002 (exclusive of environmental scientists) and 62,000 medical scientists (who typically get Ph.D.s in the life sciences.) These two groups are expected to grow by 19% and 27% respectively by the year 2012.

Most graduate programs in the biomedical sciences are very discipline-oriented, e.g. biochemistry, cell biology, etc. This restricts the type of students entering the program and limits the training opportunities for students in the program. In contrast, the Quantitative and Systems Biology graduate group at UC Merced brings together faculty from a wide range of disciplines with broad expertise to investigate the complex systems and networks responsible for the biological functions of cells, tissues, organisms, populations, and ecosystems. The current QSB faculty is drawn from both the Schools of Natural Sciences (17 members) and Engineering (5 members) covering disciplines including molecular and cell biology, evolutionary biology, genomics, proteomics, signal transduction, experimental technologies, and computational biology. QSB students are involved in a wide range of biomedical sciences research projects, and this will continue to grow as new faculty join the graduate group. The doctoral program emphasizes quantitative analyses at multiple levels of biological systems, development and use of novel model systems, and computational and analytical approaches for the study of biological processes.

G. INITIATIVES

1. Biomedical Sciences Research Institute

Human health and health of the environment are two of the School's major research themes. These areas have many interconnections and synergies – the study of air quality in the Central Valley, the study of asthma and the study of atmospheric chemistry. These themes are captured in UC Merced's research institutes – the Sierra Nevada Research Institute, the Energy Institute and the Biomedical Sciences Research Institute (BSRI). This Institute builds on the stellar technologic base in biomedical research that is evolving at UC Merced. The Institute is envisioned to form one of the research arms of medical education as educational programs for health professionals develop at UC Merced. Originally proposed as the Biomedical Sciences and Systems Biology Research Institute, this institute was approved by the UC Merced academic senate in spring 2006. Subsequently, with the advent of new faculty in the School of Natural Sciences, much discussion ensued around the use of the term systems biology, and the involved faculty agreed that the title of Biomedical Sciences Research Institute was more consonant with the theme of the research intended for this research than systems biology. While the title of the institute can be modified in the future once the research agenda is further developed, it was agreed that eliminating systems biology for the short term is desirable. The proposed BSRI is the first UC Merced institute to focus specifically on human health issues and bring together faculty from the Schools of Natural Sciences and Engineering with research agendas in the health sciences. This institute will form a strong foundation for health science programs at UC Merced and support emerging plans to develop medical education and a School of Medicine. It will serve as the link between state-of-the-art biomedical and clinical research, creating a strong translational research component to addresses the health care challenges in the region. The integration of basic, applied and clinical research fundamentals will foster stellar biomedical and community health research, spawning discoveries, technological advances, community and public health strategies to address health disparities, encourage cultural competency, and importantly, impact the region in which the research is carried out. The BRI is envisioned to have a faculty director, 12-15 core faculty, and a larger number of affiliated faculty members with research interests that fall within the scope of the Institute's mission. The Institute is built around technologic cores of cutting edge research and instrumentation that can be accessed by faculty and students campus-wide. Cores that support the clinical and translational research for health and biomedical sciences may also be part of this institute. A 5-year plan with extensive fundraising efforts is envisioned. A search for a potential director of the BSRI is underway in AY 2008-2009 and is being led from the Provost's office.

2. Planning for Medical Education at UC Merced

The University of California recently completed a comprehensive analysis of California's short- and long-term health needs. The shortage of health care providers and the state's changing demographics, including aging, increasing diversity, and a growing load of chronic disease, in a population that is growing at twice the national average, mandate expanded health career training opportunities. Recent analyses of the health care status of the San Joaquin Valley revealed wide-spread disparities in health care access and health

care provider shortages across the region relative to the state of California. A number of recommendations to address these disparities were suggested, including increasing training opportunities for physicians and other health care professionals in underserved regions of California, such as the Central Valley and the Inland Empire. UC Merced has been actively promoting development of a medical education program, on a trajectory toward a medical school.

While this is a campus-wide initiative, much of the initial planning has been lead by the administrative leadership of the School of Natural Sciences, with input from faculty across the campus. A history of the chronology and planning process can be found at http://med.ucmerced.edu/. Briefly, the planning process involved conceptualization of a medical school at UC Merced by a faculty-community task force in December 2005, Divisional Academic Senate endorsement of a medical school concept for UC Merced in Spring 2006, submission of a plan for medical education to UCOP in June 2006, inclusion of a 32 seat allocation for a UC Merced inaugural medical school class by the UCOP Health Enrollment Task Force within the next decade (2012 proposed target date), and recommendations to UCOP by a joint UC Merced-UCD-UCSF academic task force that met in December 2006 to discuss development options for a medical school at UC Merced, based on inter-campus partnerships. A draft business plan completed in 2007 describes the educational mission of the medical school and initial research thrusts. The proposed school is based on a regional distributed model of medical education that leverages partnerships with community health care institutions for clinical training, while the instruction and research in basic and applied sciences are carried out on the UC Merced campus.

Continued planning for a medical school is a lengthy process requiring endorsement at multiple levels within the UC system and external to the UC system. Once this planning is completed and a medical school endorsed by the Regents and elected officials in Sacramento, UC Merced will have a professional school whose graduates will impact health care access in the region, and which will provide a research foundation for research in basic and applied sciences, as well as population-based health. The research agenda of the medical school will provide opportunities for integration of efforts across the campus in areas that impact health science and health care including health policy, economics, social sciences, health informatics, health care delivery, multi-cultural medicine, and of course basic and applied sciences. Most universities that belong to the American Association of Universities (AAU) have professional schools. The medical school at UC Merced will help the campus with its aspiration to become to belong to the AAU and become a comprehensive UC campus.

3. Science-Math Initiative (SMI): California Teach

To address the critical need in California for highly qualified K-12 teachers in science and mathematics, the University of California, in partnership with other segments of California's K-16 educational system, has the goal to produce annually 1,000 or more highly qualified science and mathematics secondary school teachers by 2010[1]. Since each

[1] See http://www.universityofcalifornia.edu/academics/1000teachers/proposal.pdf

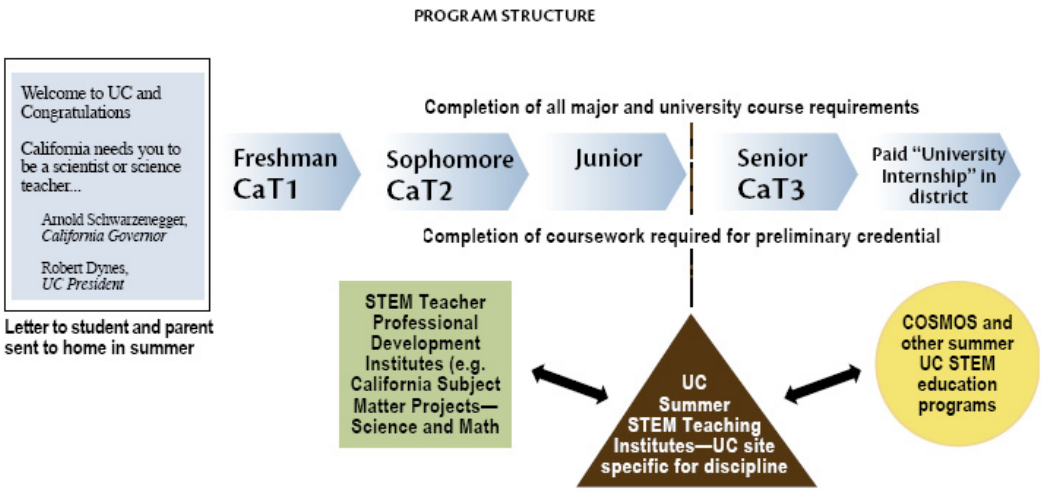
teacher can touch the minds of more than one thousand students during 10 years of teaching, one thousand teachers will touch the minds of more than one million California children. These UC-educated teachers will become the future educational leaders of our schools and will be a key element in helping California maintain its global economic position in science, technology and innovation.

The program enables UC Merced undergraduate students the opportunity to complete a UC major in a science, technology, engineering or mathematics (STEM) field while completing the coursework that will prepare them to be a highly qualified science or mathematics secondary teacher in four academic years. Immediately upon completion of this program, students would be eligible to become a "teacher of record" in a California high school, and be paid by the district at the level of an entry level teacher. These "University Interns" or "District Interns" will be supervised during the internship either by the sponsoring university or the district. In both cases, these interns would be considered as "highly qualified teachers" by "No Child Left Behind" definitions.

The model for this "dual track" program is depicted below. It is an idealized model for the student who had been accepted to UC as a freshman and who decided to begin the dual track program in the first year. We know from the experiences of the Texas U-Teach program that programs must allow for multiple entry points as different students may decide to enter teaching at different points in their undergraduate careers. We also realize that we will need to work very closely with our community college partners to ensure that community college students who are interested in going into science and math secondary teaching are given the opportunity to participate in this program prior to transferring to UC. Taking into consideration these guidelines as well as the SMI experiences of other UC campuses we are currently implementing the SMI program while adapting existing models to the needs and capacities of UC Merced and the local school districts.

The model consists of several elements including:

- initial recruitment of students into the program,
- coursework and fieldwork that will constitute the Science and Mathematics Education Track within Natural Sciences Majors and lead towards obtaining teaching credential, lower-division program elements,
- coursework required for subject matter preparation and education preparation,
- the UC Summer STEM Teaching Institutes, and
- financial incentives and support systems for student participants.



Current interest in the program is high, with 90 math/science/engineering majors enrolled in the first CAT course delivered in Fall 2007. The goal of this program is to graduate 30 science/math/engineering majors/year within 3 years, who are prepared to directly enter a teacher credentialing program. One component of the preparation is envisioned to be a minor in math and science education. Our initial partner for credentialing is CSU-Stanislaus, who will provide the training required for teacher certification. The ability of this program to graduate students with subject matter content knowledge in math and science to become teachers, who ideally will stay in the region, will substantially elevate the level of math and science preparation of students who will enter four year institutions, including UC Merced.

4. Student Academic Success

The School recognizes the challenges associated with preparing our diverse student body to be successful in science and math courses and in Science majors. The School has created a science student retention program, called "Excel!" that targets students who are struggling due to the lack of academic preparation for a science major. In reviewing various model programs for improving student achievement, one model emerged as both rigorous and successful. Natural Sciences students on academic probation and subject to academic disqualification are required to participate in the program. All Natural Sciences students are welcomed to participate. The program requires that Excel! Students participate in relevant lower division math and science workshops led by advanced students. These advanced students work with faculty to ensure that the workshop content is relevant to course. Excel! students are expected to attend skills workshops and tutoring established by the Student Advising and Learning Center to help them strengthen their study techniques and their understanding of the course material. These students are required to attend faculty office hours and TA office hours at least once each semester. Beginning Spring 2007, Excel! students have an opportunity to enroll in a one-unit seminar course to help them better acclimate to the university culture and expectations.

As part of the course, students will meet with an assigned faculty or graduate student in a small mentoring group for an hour a week to further develop material taught in lecture. Students who fail to meet the terms of their contract are dropped from the program. Failure to participate in the program coupled with poor academic performance results in dismissal from the School. This collaborative method enforces critical thinking and problem-solving skills. While this program is be very effective in helping low-performing students get back on track it is also useful to help students *avoid* being placed on academic probation or becoming subject to dismissal.

Excel! has worked with 149 Natural Sciences students whose grade point averages (GPAs) were below 2.0 since fall, 2005. The GPAs of 110 of these students have improved and returned to "good standing." More than 65% (96) of the 149 students earned at least a 2.0 or higher GPA after one semester and 74% (110) had achieved a GPA of 2.0 or higher after 2 semesters. Of the remaining 39 (26%) students who participated in the Excel! Program, 21 were dismissed after one or two semesters without improving their GPAs, 14 withdrew from the university and 4 are still working to improve their status.

5. Science and Math Education Center

Improving the level of educational achievement in the San Joaquin Valley is an important component of the rationale to locate the 10th campus of the University of California system in Merced. The SMI program is a natural extension of other UC Merced efforts to address the challenges of inadequate levels of preparation for students from the Valley and the creation of a college going culture in the Valley. As the relationship between SMI program and the local K-12 education partners grows and develops, it is important to consider programs that would directly benefit local teachers and students in preparing students for success in science and math courses and careers.

Some of the faculty in the School of Natural Sciences are considering creation of a Science and Mathematics Education Center. Such a center would encompass SMI and focus (i) on educating UC Merced science and math students who are interested in becoming teachers, (ii) working with in-service teachers and schools who want to improve the level of science and math education, and (iii) developing pipeline building programs that would benefit UC Merced by addressing the quantity and quality of students applying for admission to the university from the Central Valley. The prototypes of the components of such center already exist within the SMI program. Through the SMI courses, we are partnering with local schools and bringing inquiry-based science and math education methods into local schools through joint work of SMI students and local teachers. Summer institutes and seminars focused on both improving students' understanding of science and math concepts and their ability to communicate and teach them to others are in the planning stages and will help to serve as bridge programs for our students as well as preparation improvements for high school students from the region. These programs will help to recruit students into science and math majors. Early experiences with implementing and evaluating these programs will help guide the planning and development of a future math and science education center.

H. SPACE AND FACILITIES

The availability of research space is the greatest impediment to the development of viable and stellar academic programs in the sciences. The campus-wide space issue was addressed in the 2006 report of an *Ad Hoc* Campus Space Committee. While the report contains many useful data, some assumptions, particularly the expected number of graduate students and post doctoral fellows per faculty member, minimized the severity of the problem. Currently, a single campus building (the Science & Engineering Building, SE1) contains all of the offices and most of the research laboratories for the Natural Science and Engineering faculty, administrative space for Natural Science and Engineering, student support space, and the instructional laboratories for Natural Science and Engineering courses. Most of the SNS faculty have their research space in SE1. Some faculty (3 SNS faculty, and 2 joint appointments with the School of Engineering) are housed at Castle; an off-site UC Merced facility eleven miles by road from campus. The location of the SEM/TEM, mass spectrometer, Genome Center of Excellence, and two NMR's indicated that faculty needing access to these facilities should have priority for locating at Castle. Similarly, the emerging program in Solar Energy, which is also located at Castle, suggests that energy research is a good programmatic fit at this site.

To date, 38,495 asf (37%) of space in SE1 has been assigned to Natural Sciences. The School of Natural Sciences currently has 35 research-active faculty, and fifteen more searches are underway during AY 2007-2008. The space allocated to the School of Natural Sciences in the SE1 building will be completely filled with the 07-08 faculty hires. In fact, the School will be short 14 offices and approximately 3 laboratory spaces if all of the 07-08 searches are filled. The School uses the space allocation guidelines in recommended by the *Ad Hoc* Campus Space Committee as a baseline for assigning space. It is recognized that some faculty will require additional space, and some may require less, depending upon the size of the research group. The dean has authority over space allocations.

The second Science and Engineering building (SE2) is due to be ready for occupancy in 2013-2014. This building will contain 25,700 asf of research space. It is clear that the size of the building needs to be increased, and creative solutions for public private partnerships for new space need to be identified.

The administration and the faculty are working together to address the space constraints. Temporary (modular) buildings can help considerably in the short term, providing office space for graduate students and post-doctoral fellows, freeing up more room in the laboratory. Space for computational faculty and their research programs may also be located in modulars, freeing up office space in close proximity to laboratories for faculty with experimental programs. The Castle facility must play a role in alleviating the campus space crunch. Castle buildings 1200 and 1201 contain ~25,500 asf of research space and another ~20,000 asf of office space. The distance and time (11 miles, ~25 minutes) between the two Castle buildings and the main campus, the need for frequent

faculty supervision of students performing laboratory research, the lack of transportation between Castle and the campus, and limited parking on campus, complicate use of Castle for research programs. Significant resources would have to be invested into Castle to make it a viable satellite campus. Most UC campuses have satellite campuses within 10-20 min of the main campus and invest the resources to make the satellite campus viable for research-intensive faculty.

The Dean of Natural Sciences submitted a proposal to Provost Alley on October 17, 2007 requesting lab and office space for 2007 – 2013. Beginning in July, 2008 the School anticipates a shortage of 14 faculty offices and 3,000 ASF of research space. In order to recruit top quality faculty we are requesting 1,000 asf per lab as an incentive for faculty to locate at Castle. Table H1 presents our overall need for research and office space through AY 2013. By the year 2013 we will need new space for 54 faculty offices, 5 administrative offices, 43,000 asf for research space, 176 seats for graduate students and 112 post doc seats.

Table H1: School of Natural Sciences Space Requirements Summary

	Actual '05-'06	'06-'07	'07-'08	'08-'09	'09-'10	'10-'11	'11-'12	'12-'13
Faculty FTE	27	31	39	46	53	61.5	69	77
Unfilled Faculty FTE	4	10	5	7.5	8.5	8	8	8
Grads	11	27	45	90	114	138	162	186
Postdocs	11	25	32	48	64	80		
Space Needed[a]	29,800	28,000	39,000	47,000	55,000	63,000	71,000	79,000
Space Assigned to SNS[b]	*24,200*	*~38,000*	*38,000*					

[a] For faculty laboratories and offices only
[b] Includes space in Science & Engineering I

Table H2: Types of Research Space Required

	2007-2008	2008-2009	2009-2010	2010-2011
Research (wet & dry)	3,000	8,000	8,000	8,000
Office	1,820	1,040	1,040	1,040
Totals	4,200	9,040	9,040	9,040

I. PUBLIC SERVICE

Public service is one of the foundational elements of a UC campus. The faculty in the School of Natural Sciences addresses the needs of its stakeholders and beyond in three major areas: research, teaching, and community partnerships.

Research: The School of Natural Sciences faculty is involved in basic and applied research that increases understanding of environmental systems and environmental stewardship, health sciences and human health, materials science and energy, precise control over the fundamental building blocks of ordinary matter, and organic electronic materials, photovoltaics, photonic materials, nano-scale electronics, and "smart" materials. Faculty translates discoveries into practical knowledge and innovations that benefit California and the nation.

Teaching: Through its undergraduate majors and graduate programs the School of Natural Sciences at UC Merced is preparing the future workforce with science and math content knowledge that can be applied to a wide variety of careers in science, technology, government, education, health, and environmental stewardship. Through the Science and Math Initiative, faculty members in the School of Natural Sciences have taken the lead in developing programs to increase the number of math and science subject-matter-credentialed teachers in the region.

Community Partnerships: In addition to the partnerships of the School of Natural Sciences and the K-12 institutions in the region through the Science and Math Initiative, the School has sponsored programs to increase community awareness about science and mathematics career opportunities and benefits of science to society.

Public events are hosted by the School to stimulate interest by K-12 students in higher education and potential careers. 1) Health Careers Day provides information to potential UC Merced students about health profession career opportunities. 2) Weird Chemistry Night attracts over 300 elementary students and their families to campus to experience chemistry in an interactive presentation. 3) Dinner with a Scientist hosts science-START teachers who bring their high school students to meet faculty and interact over dinner.

The School hosted the regional finals for the 2007 Science Olympiad for more than 750 middle school and high school students. The 2008 Science Olympiad Regional finals will also be hosted at UC Merced. The School has also been the host to several summer institutes for underrepresented high school students (MESA), the Flynn Institute for high school Physics teachers and HECHT for Chemistry teachers.

School faculty participate in numerous public lectures and forums in the community and serve on a number of community advisory boards. They have forged collaborations with regional institutions around both research and teaching. An excellent example of these

collaborative efforts is linkage of SMI programs with the Center for Educational Partnerships. Faculty laboratories have been opened to tours of students in elementary and secondary schools and they have led and participated in summer institutes for secondary school students.

J. METRICS OF SUCCESS FOR RESEARCH AND ACADEMIC PROGRAMS

Overall Metrics

The success of the School in meeting its goal and objectives can be assessed using a number of metrics, some of which are described below.

A. Research excellence
   1. Peer-reviewed publications
   2. Natural Science contributions in moving UC Merced toward a Tier I AAU research intensive institution
   3. Peer-reviewed funding

B. Recognition of faculty stature and accomplishments
   1. Awards and elected membership in prestigious scientific organizations such as National Academies of Sciences, society fellows, etc.
   2. Elected scientific society leadership positions
   3. Participation in national and international science advisory committees
   4. National and international speaking engagements

C. Faculty recruitment and retention
   1. Normal academic advancement and progression
   2. Continued recruitment of outstanding faculty

D. Creating a School that reflects the diversity of California
   1. Moving toward creating a faculty that reflects the diversity of our anticipated student body (richly diverse in ethnicity and socioeconomic background).
   2. Increasing numbers of students from the region, the state and beyond enrolled in undergraduate science majors and graduate inter-disciplinary graduate programs.

E. Excellence in pedagogy and curriculum innovations.

F. Placement of students in higher education programs such as graduate school and professional programs.

G. Increasing enrollments of students in upper division courses in each of the majors offered by Natural Sciences and an increasing graduation rate in each of the majors.

H. Effective university and public service

Faculty Mentoring

The senior faculty members of the School of Natural Sciences strongly support the premise that the School, through its senior faculty, must provide each of our Assistant Professorial hires with a nurturing environment that will enable their development as researchers and scholars. This is particularly important in our current start-up mode where there are endless opportunities for diversion from those areas that are the necessary elements in successful promotion and tenure decisions.

The School of Natural Sciences is developing a mentoring plan intended to provide meaningful guidance and time needed to develop competitive research programs for all assistant professors. This plan includes a number of elements. One element of the developing program is facilitating establishment of ongoing counseling relationships with a senior faculty mentors. The senior faculty member will be a strong source of career guidance and will help assistant professors to make informed choices regarding their involvement in committee work and teaching activities that can reduce their commitment to research. Perhaps, most importantly, the mentor should help to facilitate the development of meaningful research collaborations both here and at other campuses.

Second, the faculty has agreed to a differential teaching load for junior and senior faculty members. In order to provide the most favorable circumstances for the junior faculty retention and success, the School has chosen to provide a reduced teaching load for all Assistant Professors during their first year of appointment. During this time, the teaching load is half that of their senior counterparts. This provides additional time for faculty members to establish and develop their laboratories and research programs, essential elements of success in the School of Natural Sciences.

It should be noted that implementation of this mentorship plan will be difficult if the initial goal of building a strong foundation of senior faculty is derailed as a result of budgetary limitations. Most established campuses have a preponderance of tenured faculty from which to draw appropriate mentors. At UC Merced, after the initial recruitment of senior faculty, most of the subsequent hires have been concentrated at the junior level. Continuation of this will dilute the School's ability to provide a meaningful mentorship program and hamper effective mentor.

School of Natural Sciences Planning Summary						
		AY 2005-2006 (actual)	AY 2006-2007 (actual)	AY 2007-2008	AY 2008-2009 (projected)	AY 2009-2010
INCOMING STUDENTS						
Frosh		273	201	243	284	284
Transfers (jrs)		25	44	44	32	32
Undeclar joining Nat Sci		37	45	72	85	85
Grad students		10	17	28	45	45
TOTAL Nat Sci STUDENTS						
Frosh		273	201	243	284	284
Soph		2	146	134	268	284
Jr		40	86	172	191	300
Senior		2	32	45	237	191
Grad		26	27	45	90	113
Totals		343	492	639	1070	1172
ENROLLMENTS by DISCIPLINE						
BIO		721	810	907	1483	1705
CHEM		497	835	1107	1730	1990
ESS/IB		62	58	646	920	1058
MATH		888	1242	1818	2610	3002
PHYSICS		259	421	539	1130	1300
NSED		0	61	124	150	173
Total UG enrollments		2427	3427	5141	8023	9226
Physics & Chemistry			35	42	84	168
ES		14	28	26	52	104
QSB		58	172	170	340	680
AMGS			17	92	184	368
Total Grad enrollments		72	252	330	660	1320
FACULTY *						
Filled		27	31	39	46	53.0
Unfilled		4	10	5	7.5	8.5
Total		31	41	44	53.5	61.5
Auth/Req for following year		10	9	9.5	8	8
Lecturer FTE		4	7	9 **	9	9
WORKLOAD RATIOS						
BIO				1:08	1:14	1:14
CHEM				1:33	1:33	1:33
ESS				1:14	1:11	1:11
MATH				1:44	1:40	1:40
PHYSICS				1:16	1:18	1:18
NSED				1:16	1:20	1:20
Total FTE/faculty		1:15	1:16	1:20	1:22	1:22

* includes all Asst, Assoc & Full Profs including Traina, Pallavicini & Alley who have primarily administrative positions

** budgeted for 5.5 lecturer fte, used 9.0 fte