Spring 2009

Chemical & Nuclear Engineering 2009 APR Self-Study & Documents

University of New Mexico

UNM

Department of Chemical and Nuclear Engineering

Academic Program Review

for

Chemical Engineering B.S., M.S., and Ph.D. Degree Programs

Nuclear Engineering B.S., M.S., and Ph.D. Degree Programs

April 2009

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1. General Program Characteristics

Department History and Overview

The current Department of Chemical and Nuclear Engineering has its roots in an undergraduate Department of Chemical Engineering founded in 1946, and a graduate Nuclear Engineering department founded in 1965. The departments were administratively combined in 1972. The present Department of Chemical and Nuclear Engineering offers ABET-accredited B.S. programs in both chemical and nuclear engineering, as well as M.S. degrees in both disciplines and Ph.D. in Engineering degrees with concentration in Chemical Engineering or Nuclear Engineering. The B.S. chemical engineering program has been ABET accredited since 1976, and the nuclear engineering program has been ABET accredited since 1984. More details on the last ABET visit are provided in Section 2. The faculty of the Department of Chemical and Nuclear Engineering also teach and provide support to the interdisciplinary Ph.D. program in Nanoscience and Microsystems (NSMS), and to an M.S. program in Medical Physics in collaboration with the Department of Radiology at the UNM Health Sciences Center. In addition, a new biomedical engineering program is developing, largely through faculty in chemical engineering

The mission of the undergraduate programs in the Department of Chemical and Nuclear Engineering is to provide an outstanding education that prepares students to be productive and responsible members of society, with the skills and knowledge to be successful in their professional careers or post-graduate studies. This is accomplished by engaging students in a variety of academic, research and service activities, and fostering a learning environment that is supportive for a body of students that is diverse in terms of age, gender, ethnicity, and prior educational background. These programs support the mission of the University, part of which is to "…provide students the values, habits of mind, knowledge, and skills that they need to be enlightened citizens, to contribute to the state and national economies, and to lead satisfying lives"(UNM 2008-2009 Catalog).

The department currently has 11 tenured or tenure-track faculty associated with the chemical engineering program, and 6 tenured/tenure-track faculty associated with the nuclear engineering program. We also currently have one Lecturer for each program. In addition, the current Vice President for Research and Dean of Engineering also hold appointments in this department (and are not included in the numbers just given). There has been considerable rejuvenation on the faculty of both programs. Among the chemical engineering faculty, there have been four Assistant Professors and one Associate Professor added in the past four years. The four Assistant Professors were enabled by four retirements from the chemical engineering faculty, and the Associate Professor was hired utilizing State of New Mexico support for the development of a biomedical engineering graduate program. The nuclear engineering faculty has one new tenured full professor, and one Assistant Professor in the past two years. These were enabled by one retirement, and partial support from a new joint faculty program with the Idaho National Laboratory.

All regular faculty in the department are research active, and the department is home to several research Centers that play a prominent role in the research climate and productivity of the department's faculty. These include Center for Microengineered Materials (CMEM), Center for Biomedical Engineering (CBME), Center for Emerging Energy Technologies (CEET), Institute

for Space and Nuclear Power Studies (ISNPS), and the Center for Nuclear Nonproliferation Science and Technology (CNNST). Including expenditures through the centers, total research expenditures by the department's faculty grew from approximately $4.2MM in 2005-2006 to over $6MM in 2007-2008. We expect this growth to continue as our young faculty develop their research programs.

All programs in the department are administered by a single Chair, with an Associate Chair representing the other discipline. Currently the Chair is Tim Ward (chemical engineering) and the Associate Chair is Anil Prinja (nuclear engineering). The department operations are supported by 7 full-time staff: 1 Department Administrator, 1 Accountant, 1 Program Advisement Coordinator, 1 Administrative Assistant, 1 Graphic Designer, 1 Research Engineer (chemical engineering laboratory supervisor), and 1 Facilities Services Manager (nuclear engineering labs and facilities). The department leadership has been in some flux over the past year. The previous Chair, Julia Fulghum, accepted a position as Interim Vice President for Research (VPR) in May 2008 after serving as Chair since 2002. Tim Ward served as Interim Chair during her absence. In December 2008, it was announced that Prof. Fulghum would become the permanent VPR, and it was announced that Prof. Ward would serve as Chair for a four-year term that includes the current 2008-2009 year.

The last UNM review of academic programs in the department occurred in Spring 1995, and was focused on the graduate programs only (engineering departments did not typically review undergraduate programs due to their regular extensive ABET accreditation reviews). The 1994-1995 Graduate Review was conducted by a team of three external members and one internal member. The report from that review made note of extraordinary progress in obtaining research support, and in the focus of research efforts on important areas of chemical and nuclear engineering. The report also commented on impressive strides toward quality teaching and research in the graduate programs. Several specific recommendations were made in the report that were implemented, and have since become part of department culture. For example, a department Advisory Council was formed in part as a result of the 1995 review, and that committee has met three times since (1999, 2000 and 2004). Other issues raised by that review are as relevant today as they were then. These include strategies to improve national recognition of our programs, graduate student recruiting, and space management.

2. Degree Programs and Curricula

Chemical Engineering Undergraduate Program

The B.S. programs in chemical engineering and nuclear engineering have defined Educational Objectives and Program Outcomes that are consistent with the definitions utilized by ABET, Inc., the accreditation body for engineering programs. Program educational "Objectives" are those broad statements that describe the career and professional accomplishments that the program is preparing the graduate to achieve. Program "Outcomes" are defined as statements that describe what students are expected to know and be able to do by the time of graduation.

Educational Objectives: Graduates of the undergraduate program in chemical engineering will:

1. have the technical knowledge and skills to achieve success in their chemical engineering-related professional or post-graduate educational endeavors.
2. think creatively, applying problem-solving skills to engineering design and other professional activities.
3. be able to communicate effectively.
4. be able to function effectively on independent projects and as a member of multidisciplinary teams.
5. understand their professional and ethical responsibilities, and the social and environmental impacts of their work
6. pursue post-graduate learning and professional development throughout their careers.

Program Outcomes: By the time our graduates complete the chemical engineering program, they will have successfully demonstrated the following:

(A) an ability to apply knowledge of mathematics, science, and engineering to chemical engineering problems.
(B) an ability to design and conduct experiments, and analyze and interpret data.
(C) an ability to design processes, systems or components to meet desired needs, subject to realistic constraints, such as economic, environmental, social, political, ethical, health, safety, manufacturability, and sustainability.
(D) an ability to function on multidisciplinary teams.
(E) an ability to identify, formulate, and solve engineering problems.
(F) an understanding of the professional and ethical responsibilities of engineers.
(G) an ability to communicate effectively.
(H) an understanding of the global, economic, environmental, and societal impacts of engineering activities.
(I) a recognition of the need for lifelong learning, and an awareness of how this can be achieved in their career.
(J) a knowledge of contemporary issues.
(K) an ability to use modern techniques, skills, and engineering tools to address problems encountered in engineering practice.

Assessment procedures for the educational objectives and program outcomes are presented in Section 3 below.

The curriculum for the B.S. programs in chemical engineering is shown on the next page. The chemical engineering program builds on a foundation of chemistry, physics, and calculus/ordinary differential equation in the freshman and sophomore. The program offers five concentrations, usually chosen by students in the sophomore year in consultation with a faculty advisor. The concentrations are:

- Chemical process engineering
- Bioengineering
- Materials processing
- Semiconductor manufacturing
- Environmental engineering

The concentration affects the choices for the basic science concentration, the chemistry concentration electives, and technical electives. All students complete a traditional suite of chemical engineering core courses which includes thermodynamics, unit operations, transport phenomena, reactor engineering, computational methods and tools, laboratories, and process control. The concentration chosen affects the choices of advanced chemistry/biology courses, one basic science elective course, and three technical elective choices.

Responses to Previous ABET Accreditation Review

The B.S. Chemical Engineering program was reviewed for accreditation in the 2004-2005 academic year. There was an interim visit in 2006, in response to one weakness and one concern. Subsequent to that visit the program was accredited to September 30, 2011, and the accreditation visit is expected in Fall 2010. The 2004-2005 evaluation noted one program "weakness" under ABET Criterion 5 (Faculty). Student comments indicated inappropriate faculty behavior in and out of the classroom. Since the 2004-2005 review, four faculty members have retired and five new faculty members have been hired. That weakness was deemed resolved after the interim visit in 2006. The 2004-2005 visit also resulted in one program "concern", under ABET Criterion 6 (Facilities) It was noted that "to the students, the current overall laboratory experience is compromised by the poor condition of the facilities that house the laboratory and by the poor condition of some of the equipment that has not been updated. Many students felt that the computer facilities are in poor condition and that greater access to computers would be beneficial. In addition, they also report instances of problems in running some software." At the time of the 2006 interim visit, the laboratories were in temporary space pending the completion of the Centennial Engineering Center. Computers had been replaced, but students still expressed concerns over software support. The concern remained unresolved after the 2006 interim visit. Since that time, the CEC has been completed, and our new state-of-the-art laboratories are now in full operation. We have continued to renovate computer facilities, improve support and access to wireless internet, and we believe these concerns have now been resolved.

UNIVERSITY OF NEW MEXICO--SCHOOL OF ENGINEERING

CURRICULUM FOR BACHELOR OF SCIENCE DEGREE IN CHEMICAL ENGINEERING-EFFECTIVE FALL 2008

Hours required for graduation: 132[1,2]

Freshman Year

Fall Semester			**Spring Semester**		
	Cr	Contact Hrs. Lect-Lab		Cr	Contact Hrs Lect-Lab
ChNE 101 Intr Che & Nuclr Engr	1	(1-0)	CS 151L Comp Prog Fund	3	(3-1)
Math 162 Calculus I	4	(4-0)	Math 163 Calculus II	4	(4-0)
Chem 121 Gen Chemistry	3	(3-0)	Chem 122 Gen Chemistry	3	(3-3)
Chem 123L Gen Chem Lab	1	(0-3)	Chem 124L Gen Chem Lab	1	(0-3)
Engl 101 Comp I: Exposition	3	(3-0)	Engl 102 Comp II: Analys & Arg	3	(3-0)
Core Humanities Elective[3]	3	(3-0)	Phys 160 Gen Physics	3	(3-0)
	15	(14-3)		17	(16-4)
Sophomore Year					
ChNE 251 Chem Proc Calc I	3	(3-0)	ChNE 253 Chem Proc Calc II	3	(3-0)
Math 264 Calculus III	4	(4-0)	ChNE 302 ChE Thermodynamics	4	(4-0)
Chem 301 Organic Chem	3	(3-0)	Math 316 App Ord Diff Eq	3	(3-0)
Chem 303L Organic Chem Lab	1	(0-3)	Basic Sci Concentration[5]	3	(3-0)
Phys 161 Gen Physics	3	(3-0)	Adv Chem Concentration[6]	3	(3-0)
Econ 105 Intro to Macroeconomics[4]	3	(3-0)			
	17	(16-3)		16	(16-0)
Junior Year					
ChNE 311 Intro Transpt Phenomena	4	(4-0)	ChNE 312 Unit Operations	3	(3-0)
ChNE 317 Chem Engr Analysis	3	(3-0)	ChNE 321 Mass Transfer	3	(3-0)
Engl 219 Tech Writing[4]	3	(3-0)	Basic Engr Elective[7]	3	(3-0)
ChNE 318L Chem Engr Lab I	1	(0-3)	ChNE 319L Chem Engr Lab II	1	(0-3)
Adv Chem Concentration[6]	3	(3-0)	Adv Chem Concentration[6]	3	(3-0)
ChNE 361 Biomolecular Engr	3	(3-0)	ChNE 371 Intro Materials Engr	3	(3-0)
	17	(16-3)		16	(15-3)
Senior Year[9]					
ChNE 418L Chem Engr Lab III	1	(0-3)	ChNE 419L Chem Engr Lab IV	2	(0-5)
ChNE 451 Senior Seminar	1	(1-0)	ChNE 454 Proc Dynamics & Control	3	(3-0)
ChNE 461 Chem Reactor Engr	3	(3-0)	ChNE 494L Adv ChE Design	3	(2-3)
ChNE 493L Chem Engr Design	3	(2-3)	Technical Elective[8]	3	(3-0)
Technical Elective[8]	3	(3-0)	Core Fine Art Elective[3]	3	(3-0)
Core Humanities Elective[3]	3	(3-0)	Core Second Language Elective[3]	3	(3-0)
Core Social/Behavior Science Elec[3]	3	(3-0)			
	17	(15-6)		17	(14-8)

1. Only courses with grades of C- or better may be applied toward the bachelor of science degree in chemical engineering.
2. Students must file an application for the B.S. degree prior to the completion of 95 semester hours of applicable courses.
3. Students should consult with advisors to obtain a list of acceptable core humanities, social/behavioral science, fine arts and second language electives. These courses may be taken whenever convenient. Grade must be C- or better.
4. Econ 105 and Engl 219 may be taken in either the sophomore or junior year.
5. Physics 262 or Biology 201L, depending on the student's area of concentration.
6. A minimum of 9 credit hours of advanced chemistry, selected from among CHEM 302, 311, 312, 421, 431 or BIOC 423, depending upon the student's area of concentration. One semester of Physical Chemistry is required for all concentrations. Up to four hours of other natural science courses may be substituted for advanced chemistry. Such advanced natural science courses must build on basic science prerequisites and may include physics, life sciences, and material science. The courses chosen must represent a logical sequence of courses for the concentration and must be approved by the academic advisor.
7. Recommended course ChNE 213. Alternatives are CE 202 or ECE 203. Students in the semiconductor processing concentration may wish to take ECE 203.
8. Technical electives are chosen from approved upper division courses in engineering, mathematics and science. The department requires that these courses be part of an approved concentration. The chairperson may allow up to 6 hours of technical electives for students taking required ROTC courses in aerospace or naval science.
9. Students are encouraged to take the Fundamentals of Engineering (FE) Examination during their senior year. This is the first formal step toward professional registration.

Persons having special needs and requiring auxiliary aid or service should contact the Department of Chemical and Nuclear Engineering (ADA and Rehabilitation Act of 1973)

October 2006

Recent Curriculum Changes

Several other changes have been made to the chemical engineering curriculum since the last accreditation review. These changes were prompted in part by the accreditation review, but most were the result of our assessment process for educational objectives and program outcomes, described in more detail below. Underlying this is the desire to maintain a curriculum that serves the needs of contemporary chemical engineers. These changes were made without increasing the total number of credit hours in the curriculum (132). The changes include the following:

- The two-semester thermodynamics sequence was reduced to a 4-credit one semester course. We felt that a beefed up one-semester course, supported by some thermodynamics in the physics sequence and physical chemistry course was adequate. This addressed an observation by the ABET accreditation team regarding content overlap in thermodynamics courses, and provided some breathing room to make other changes to the curriculum.
- A new in-house materials science course was created and made a mandatory part of the curriculum. Before that materials science was optional, and students took the courses offered in mechanical or civil engineering. Developing our own course has allowed us to have control over content, and include more nontraditional topics of interest to chemical engineers.
- A new Biomolecular Engineering course was added to the curriculum as a mandatory core course. This was in response to a clear developing need for chemical engineers to be more literate in biology and engineering applications of biology.
- The laboratory sequence has been restructured so that each of the four laboratory courses follows and emphasizes content related to a particular lecture course. The first laboratory course is related to thermodynamics, and students must complete the thermodynamics course before taking the lab. Similarly, the second lab addresses fluid flow and heat transfer, the third addresses mass transfer, and the last addresses kinetics and process control.

Chemical Engineering Graduate Program

The department offers M.S. Degrees in Chemical Engineering under both Plan I (thesis) and Plan II (non-thesis), and the Ph.D. in Engineering with a concentration in Chemical Engineering. The M.S. thesis degree requires 6 credit hours of thesis and 24 credit hours of courses, which includes the following set of mandatory core courses:

- ChNE 501/502: Graduate Seminar (required every semester up to 4 semesters for M.S. students, up to 8 semesters for PhD students) – 1 cr (up to 3 counted toward 24)
- ChNE 521: Advanced Transport Phenomena I – 3 cr
- ChNE 525: Methods of Analysis in Chemical and Nuclear Engineering – 3 cr
- ChNE 561: Kinetics of Chemical Processes – 3 cr
- ChNE 542: Advanced Chemical Engineering Thermodynamics – 3 cr

The plan I M.S. exam consists of an oral defense of the thesis. The plan II M.S. requires 33 credit hours, and includes the same set of mandatory core courses. The plan II M.S. exam consists of an oral examination based on a project (typically 1 semester) done under the supervision of a faculty member.

The Ph.D. degree requires a minimum of 48 credit hours beyond the B.S. degree, or typically 18 hours beyond the M.S. (at least 24 hours coursework must be completed at UNM). In addition 18 hours of dissertation credit are required. Major milestones in the Ph.D. program include

- Qualifying Exam: Students are allowed only one grade below A- in the graduate core courses (in addition to maintaining a cumulative overall GPA of 3.0 or higher). Any student who earns more than one grade below A- must take a Written Exam in the subjects where they failed meet the standard. All students take an Oral Qualifying Exam that consists of presenting and orally defending a research proposal. They identify a topic in consultation with their research advisor, then develop and defend the proposal independently before a faculty committee.
- Comprehensive Exam: The comprehensive exam is an oral presentation and defense of the proposal for the research that will lead to the dissertation. It is typically taken at least one year before graduation, but after significant results have been obtained. This exam is conducted by the Committee on Studies, which usually also makes up most of the dissertation examination committee
- Dissertation defense: This is an oral presentation and defense of written dissertation.

The chemical engineering program has a graduate advisor and graduate admissions committee who evaluate and rank graduate applications. Applications for candidates deemed admissible are forwarded to faculty to consider for admission. Because of limited departmental resources and essentially no T.A. resources, prospective graduate students are typically admitted to a particular research group/professor, and begin R.A. support with that professor when they arrive. Typical R.A. support averages about $1700 per month, ranging from ~$1500 to $1800/month, and tuition ($1326.60 to $2628.20 per year) and health insurance (~$1500/yr) is also paid from research contracts. In addition, some students carry competitive fellowships that pay better than the numbers above. Graduate admission statistics are summarized in Section 5 below.

Nuclear Engineering Undergraduate Program

The undergraduate B.S. program in nuclear engineering has defined Educational Objectives and Program Outcomes that are consistent with the definitions utilized by ABET, Inc., the accreditation body for engineering programs. Program educational "Objectives" are those broad statements that describe the career and professional accomplishments that the program is preparing the graduate to achieve. Program "Outcomes" are defined as statements that describe what students are expected to know and be able to do by the time of graduation.

Educational Objectives: Graduates of the undergraduate program in Nuclear Engineering will:

1. have the technical knowledge and skills to achieve success in their nuclear engineering-related professional or post-graduate educational endeavors.
2. think creatively, applying problem-solving skills to engineering design and other professional activities.
3. be able to communicate effectively.
4. be able to function effectively on independent projects and as a member of multidisciplinary teams.
5. understand their professional and ethical responsibilities, and the social and environmental impacts of their work
6. pursue post-graduate learning and professional development throughout their careers.

Program Outcomes: The faculty has worked to develop a set of formal Program Outcomes and an Assessment Process that reflect our Program Educational Objectives and the ABET criteria for Nuclear and Radiological Engineering.

By the time our graduates complete our program they will have successfully demonstrated:

a. an ability to apply knowledge of mathematics, science, and engineering.
b. an ability to design, conduct, and analyze experiments involving nuclear* and non-nuclear processes, interpret data, and report the results.
c. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d. an ability to function on multidisciplinary teams
e. an ability to identify, formulate, and solve nuclear* and related engineering problems
f. an understanding of professional and ethical responsibility
g. an ability to communicate effectively
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i. a recognition of the need for, and an ability to engage in life-long learning
j a knowledge of contemporary issues
k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

* Nuclear engineering problems include nuclear processes (fission, fusion, decay, etc.), radiation interaction with matter, radiation transport, thermal hydraulics, and radiation detection and measurement.

The curriculum for the B.S. program in nuclear engineering is shown starting on the next page.

UNIVERSITY OF NEW MEXICO
SCHOOL OF ENGINEERING
CURRICULUM FOR BACHELOR OF SCIENCE DEGREE IN NUCLEAR ENGINEERING

Hours[6] Required for Graduation: 133

Fall Semester		**Spring Semester**	
Course Title	Cr. Hrs.	Course Title	Cr. Hrs.
		FRESHMAN YEAR	
Chem 121L General Chem/Lab	4	Chem 122L General Chem/Lab	4
Math 162L Calculus I	4	Math 163L Calculus II	4
Engl 101 Comp I: Exposition	3	Engl 102 Comp II: Analys&Arg	3
Ch-NE 101 Intro to ChE/NE	1	Physcs 160 General Physics	3
Core Humanities Elective[1]	3	CS 151 Comp Prog Fund	3
	15		17
		SOPHOMORE YEAR	
Ch-NE 230 Princ Radiation Prot	3	Ch-NE 231 Prin of Nucl Engr	3
Math 264L Calculus III	4	Math 316 Appl Ord Diff Equas	3
CE 202 Engineering Statics	3	**ChNE 240 Circuits for ChNEs**	3
Physcs 161 General Physics	3	Physcs 262 General Physics	3
Econ 105 Intro Macroeconomics	3	Engl 219 Technical Writing	3
Ch-NE 213 – Engr Skills	2	**Ch-NE 364 Nuclear Systems**	2
	18		17
		JUNIOR YEAR	
Ch-NE 311 Intro Transport Phenma	4	Ch-NE 312 Unit Operations	**3**
Ch-NE 317 Chem Nucl Engr Analy	3	Ch-NE 313L Intro Lab Technque	3
Ch-NE 323L Nucl Det Meas/Lab	3	**Ch-NE 310 Neutron Diffusion**	3
Ch-NE 371 Nucl. Engr. Material Sci	2	Ch-NE 330 Nucl Engr Science	2
Ch-NE 372 Nucl Reactor Engr	2	**Technical Elective[2]**	3
Core Soc. & Behav. Sci. Elective[1]	3	Core Second Lang. Elective[1]	3
	17		17
		SENIOR YEAR[3,4]	
Ch-NE 410 Nucl. Reactor Thry I	3	Ch-NE 413L Nucl Engr Lab I	3
Ch-NE 464 Thrml-Hydrl Nucl Sys	3	Ch-NE 452 Senior Seminar	1
Ch-NE 497L **NE Comp Appl**	3	Ch-NE 498L Nuclear Engr Design	4
Ch-NE 462? Monte Carlo Tech	3	Nuclear Engr. Tech. Elective[5]	3
Core Humanities Elective[1]	3	Core Fine Arts Elective[1]	3
Technical Elective[2]	3		14
	18		

1 Students should consult the UNM catalog, p.40 or an advisor to obtain a list of acceptable courses to fulfill the core curriculum requirements. These courses may be taken whenever convenient.

2 Technical electives are chosen from approved upper division courses in engineering, mathematics and science. The chairperson may allow up to 6 hours of technical electives for students taking required ROTC course in aerospace or naval science.

3 Students must file an application for the B.S. Degree prior to the completion of 95 semester hours of applicable courses.

4 Students are encouraged to take the Fundamentals of Engineering (FE) Examination during their senior year. This is the first formal step toward professional registration.

5 The NE Technical Elective is chosen from a list of approved upper division nuclear engineering courses with the approval of the student's advisor.

6 To count towards graduation credit hours, each course must be completed with a grade of C- or better. Courses used to fulfill the UNM core curriculum require a grade of C or better.

Responses to Previous ABET Accreditation Review

The B.S. Nuclear Engineering program was also reviewed by ABET in 2004-2005, and accredited to September 30, 2011, with the next visit due in Fall 2010. The report commented that the "…program's enrollment is much healthier, and the combined department continues to provide strength and benefit to both the nuclear and chemical engineering programs, while maintaining good balance and a perceived fair representation for both programs."

Recent Curriculum Changes

After the NE Faculty met on Sept. 8, 2005, the following changes were proposed and approved to the curriculum.

- There will still be 133 hours required for the degree.
- The ECE 203 circuits class has been replaced by ChNE 213 Circuits for Chemical and Nuclear Engineers. This class allows students to focus on electronics issues covered in the upper level laboratories andon instrumentation requirements of research.
- The material originally covered in ChNE 314 (Nuclear Power Systems and Diffusion Theory) has been split into two classes. The nuclear power systems part will be ChNE 314 – Nuclear Power Systems and will include Thermodynamics (as the ChE's dropped their Thermodynamics class). This class will be taught in the spring of the Sophomore year. The diffusion theory will be covered in ChNE 310 – Neutron Diffusion Theory, which will be taught in the spring of the Junior Year.
- Two classes: ChNE 301 – Thermodynamics and ChNE 450 – Engineering Economics have been dropped by the chemical engineers so these classes have been dropped from the nuclear curriculum. The material covered in ChNE 301 will now be covered in ChNE 314 while the material covered in ChNE 450 has been integrated into two classes: ChNE 312 – Unit Operations, and ChNE 498L – Nuclear Engineering Design. The addition of material to ChNE 312 also involved the increase in credit hours for that class from 2 to 3.
- ChNE 370 – Materials is being dropped by the chemical engineers. This class will be replaced by two new materials related classes. ChNE 372 –Nuclear Engineering Material Science will provide basic material science information and information on materials used in nuclear systems. It is a two credit hour course offered in the spring of the

Sophomore year. ChNE 470 – Nuclear Materials and Fuel Cycle will cover radiation effects on materials and the nuclear fuel cycle. It has been offered in the fall of the Junior year, but is not being moved to the spring of the Senior year.

As a replacement of one of the 3 technical electives required, a new class, ChNE 462 – Monte Carlo Techniques has been inserted into the fall Senior year curriculum. This class is designed to meet the changing needs of the nuclear industry for students trained in advanced computer calculational methods.

Nuclear Engineering Graduate Program

The department offers M.S. Degrees in Nuclear Engineering under both the Plan I (thesis) and Plan II (non-thesis) options, with the latter including concentrations in Radiation Protection Engineering and Medical Physics, and the Ph.D. in Engineering with a concentration in Nuclear Engineering. The M.S. thesis degree requires 6 credit hours of thesis and 24 credit hours of courses, which includes the following mandatory course:

- ChNE 466: Nuclear Environmental Safety Analysis – 3 cr
- ChNE 501: Graduate Seminar (required every semester up to 4 semesters for M.S. students, up to 8 semesters for Ph.D. students) – 1 cr (up to 3 counted toward the 24)
- ChNE 525: Methods of Analysis in Chemical and Nuclear Engineering – 3 cr

Those students who do not have a background in nuclear reactor theory will also be required to take:

- ChNE 410: Nuclear Reactor Theory – 3 cr

The Plan I M.S. exam consists of an oral defense of the thesis.

The "traditional" Plan II M.S. requires 33 credit hours and includes the same mandatory core courses. The Plan II exam consists of an oral exam based on a project (typically one semester) done under the supervision of a faculty member.

The Plan II M.S. degree concentration in Radiation Protection Engineering requires 6 hours of practicum and 30 credits of coursework, which includes the following mandatory core courses:

- ChNE 466: Nuclear Engineering Environmental Analysis – 3 cr
- ChNE 523: Environmental Radiation Measurements Laboratory – 3 cr
- ChNE 524: Interaction of Radiation with Matter – 3 cr
- ChNE 527: Radiation Biology – 3 cr
- ChNE 528: External Radiation Dosimetry – 3 cr
- ChNE 529: Internal Radiation Dosimetry – 3 cr

The exam for the Radiation Protection Engineering concentration M.S. degree consists of a defense of the student's practicum.

The Plan II M.S. degree concentration in Medical Physics requires 6 hours of practicum and 34 credits, which includes the following mandatory core classes:

- ChNE 523 L Environmental Measurements Laboratory – 3 cr
- ChNE 524 Interaction of Radiation with Matter – 3 cr

- ChNE 528 External Radiation Dosimetry – 3 cr
- ChNE 529 Internal Radiation Dosimetry - 3 cr
- CS 591 Seminars on Applied Mathematics – 3cr
- HSci 480* Human Cross Sectional Anatomy – 3 cr
- MedPhy 516 Medical Imaging 1: X-ray Physics – 3 cr
- MedPhy 517L Medical Imaging Laboratory1: X-ray Physics – 1 cr
- MedPhy 518 Medical Imaging 2: MR, Ultrasound and Nuclear Medicine Physics – 3 cr
- MedPhy 519L Medical Imaging Laboratory 2: MR, Ultrasound and Nuclear Imaging Physics – 1 cr
- MedPhy 527 Radiation Biology for Engineers and Scientists – 3 cr
- MedPhy 530 Radiation Oncology Physics – 3 cr
- MedPhy 531L Radiation Oncology Physics Laboratory – 3 cr

The exam for the Medical Physics concentration M.S. degree consists of a defense of the student's practicum

The Ph.D. degree requires a minimum of 48 credit hours beyond the B.S. degree, or typically 18 hours beyond the M.S. (at least 24 hours coursework must be completed at UNM). In addition 18 hours of dissertation credit are required. Major milestones in the Ph.D. program include

- Comprehensive Exam: The comprehensive examination is a written examination over four subject areas chosen by the student in consultation with the student's faculty advisor.
- Dissertation defense: The is an oral presentation and defense of written dissertation.

The nuclear engineering program has a graduate advisor and graduate admissions committee who evaluate and rank graduate applications. Applications for candidates that are deemed admissible are circulated to faculty to assess whether there is interest among the faculty to admit and commit funding to the student. Because of limited departmental resources and essentially no T.A. resources, prospective graduate students are typically admitted to a particular research group/professor, and begin R.A. support with that professor when they arrive. Typical R.A. support averages about $1700 per month, ranging from ~$1500 to $1800/month, and tuition ($1326.60 to $2628.20 per year) and health insurance (~$1500/yr) is also paid from research contracts. In addition, some students carry competitive fellowships that pay better than the numbers above. Graduate admission statistics are summarized in Section 5 below.

3. Assessment of Objectives and Outcomes

Overview of Assessment of B.S. Programs (NE and ChE)

The department has an overall plan that involves our key stakeholders and constituencies in defining the educational objectives, and involves stakeholders, instructors and students in assessment of the educational objectives and program outcomes, with a process that provides feedback paths to the program/course level so that deficiencies can be corrected and improvements made. This process, depicted in Fig. 1, shows an inner course-level assessment loop. Each core course in the undergraduate curricula has course outcomes that are assessed by the instructor and students each time the course is taught. Based on that course-level assessment, the instructor may make changes to the course structure, content or outcomes. The outer loop in the figure represents the process for program-level outcomes and objectives. Program objectives are determined based largely on alumni and employer feedback, and are assessed primarily by alumni and employer surveys.

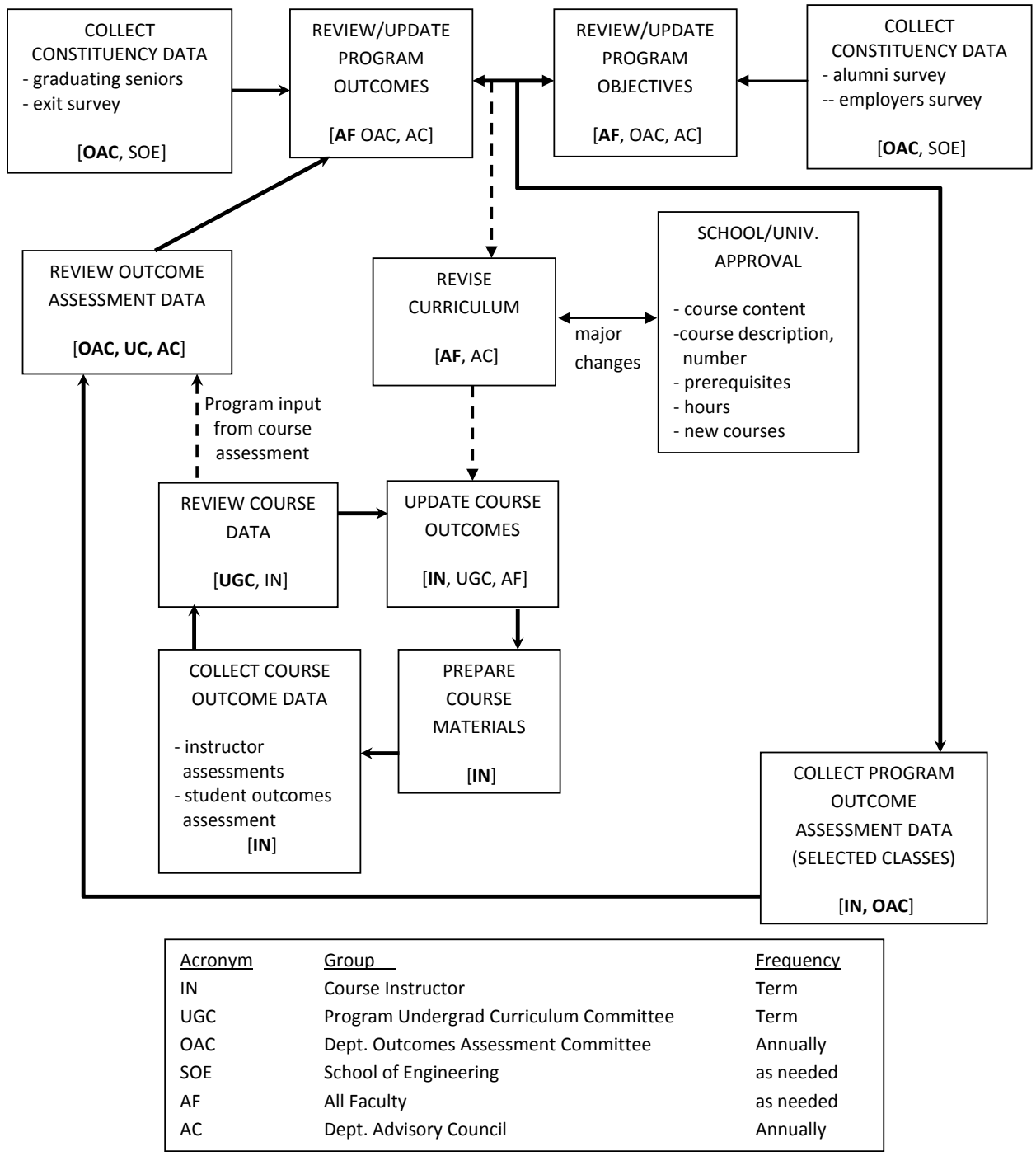
Assessment data for the program outcomes is collected from selected classes, according to a recently modified plan that is described in a separate section below. That data is reviewed by the Outcomes Assessment Committee and the Advisory Council, which may lead to review and revision of the program outcomes or other curriculum changes. A full collection of program outcome assessment data (outer loop in Fig. 1) has not been completed since the last ABET review. We began collecting program assessment data in Fall 2008 under the new assessment plan, and will continue implementing this plan over the next year and a half leading up to the next ABET visit in Fall 2010. Some of the data that have been compiled are included in this self study. One of the responsibilities of the Undergraduate Curriculum Committee (UGC) (a single committee that serves both programs) is to review course assessment data, and evaluate whether course outcomes are appropriate from the perspective of service to the overall curriculum. These reviews by the UGC represent the link between the inner loop of Fig. 1 and the outer loop where broader curriculum changes may be considered. It is this process that, in large part, has led to the "Recent Curriculum Changes" listed above in Section 2 for the chemical and nuclear engineering undergraduate programs.

Educational Objectives for Undergraduate Programs

The program educational objectives, which are shared by the chemical engineering and nuclear engineering B.S. programs, have been developed together with our constituencies, and reflect our commitment to serving those constituencies. The constituencies of the program were determined by a joint discussion of the faculty and the department Advisory Council. They include:

- students of the program,
- alumni of the program,
- employers of our graduates,
- graduate and professional schools where our graduates seek higher degrees
- faculty of the department.

Program objectives were discussed at length by faculty and the Advisory Council in Fall of 1999, Fall of 2000 and Spring 2004. The objectives were reviewed and revised again by a department committee, with subsequent discussion by the entire faculty, in Fall 2008 to make them more



Acronym	Group	Frequency
IN	Course Instructor	Term
UGC	Program Undergrad Curriculum Committee	Term
OAC	Dept. Outcomes Assessment Committee	Annually
SOE	School of Engineering	as needed
AF	All Faculty	as needed
AC	Dept. Advisory Council	Annually

Fig. 1. Schematic depicting the assessment process used for the chemical and nuclear engineering undergraduate programs.

responsive to the current programs, and more amenable to practical assessment mechanisms. An Advisory Council meeting is planned for Fall 2009, at which time educational objectives, program outcomes, and recent curriculum changes will be reviewed.

The current educational objectives of the undergraduate chemical and nuclear engineering program, revised in Fall 2008, are provided below, and can be found at the department website ((http://www-chne.unm.edu/), as well as in the University Catalog.

The educational objectives were most recently assessed by an e-mail survey of chemical engineering alumni from 2004-2006 that was conducted in May 2008. This group of graduates has not been surveyed before as alumni, and represents between 2 and 4 years after graduation, roughly the time after graduation that Educational Objectives are meant to address. Surveys were sent to 23 graduates for whom we had contact information, yielding 9 responses. A copy of the survey form is provided in Appendix B, as is a compilation of the comments. Numerical evaluations directly addressing the objectives are summarized in Table 1 below. The responses show generally good, but not universal, support for the objectives having been achieved. For every objective, at least 6 of 9 respondents responded Agree or Strongly Agree to the objective statement. The comments may shed some light on the lower ratings, and the Outcomes Assessment Committee will review the ratings and comments before Fall 2009, when this will be presented and discussed with the Advisory Council.

Alumni surveys will be done every other year, with the next planned alumni survey in spring 2010, covering graduates from the years 2007-2008. Because of the much smaller pool of alumni in nuclear engineering, a survey of NE alumni was not done in 2008, but a larger pool will be surveyed in Spring 2010.

Table 1. Summary of alumni surveys on B.S.Chemical Engineering Educational Objectives

Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. The technical knowledge and skills that I gained prepared me for success in my career and/or post-graduate education	6	1	1	1	0
2. The mathematical and computer skills that I gained prepared me for success in my career and/or post-graduate education.	5	1	3	0	0
3. My design and problem-solving experience prepared me for success in my career and/or post-graduate education.	6	2	0	0	1
4. . The communication skills that I developed prepared me for success in my career and/or post-graduate education.	4	2	2	0	1
5. My education prepared me to function effectively as a member of a multidisciplinary team.	5	1	1	1	1
6. My education prepared me to recognize and account for the social, ethical and environmental impacts of my scientific and engineering activities.	3	5	0	0	1
7. My education made me aware of the need for lifeling learning in my career, and the various ways in which this can be pursued.	5	2	1	1	0

Assessment of Program Outcomes

Over the past year, both undergraduate programs have been modifying our assessment strategy from a rather tedious matching of multiple course measurements onto each outcome into a system based on specific performance criteria for each outcome. The assessment of each

performance criterion is then matched to a specific course, where it may be based on one or particular course measurements or may be assessed by rubric. Below the program outcomes, associated performance criteria, intended assessment methods, and assessment status are summarized for chemical engineering program (Table 2) and engineering program (Table 3).

Because both programs have only just begun quantitative assessment based on the new performance criteria, very little quantitative assessment data are currently compiled. Where the first round of assessment results have been compiled, they are provided below. Additional assessment data may be available by the time of the review.

Table 2. Chemical Engineering Program Outcomes and Associated Performance Criteria.

(A) an ability to apply knowledge of mathematics, science and engineering to chemical engineering problems.

Performance Criteria	Strategies (Courses)	Sources of Assessment	Assessment Method(s)
1. Applies mathematics, including algebra, calculus and differential equations, in the formulation and solution of engineering problems	Math, ChNE 317	ChNE 311	Rubric based on several graded course tasks
2. Understands and applies chemistry to chemical engineering problems.	Chem, ChNE 251, ChNE 302, ChNE 461	ChNE 461	Rubric based on several graded course tasks
3. Understands and applies basic biology in the context of chemical engineering problems and processes.	ChNE 361	ChNE 361	Rubric based on several graded course tasks
4. Understands and applies chemical engineering fundamentals to chemical engineering problems.	ChNE 251, 253, 302, 311, 321, 461	ChNE 461 ChNE 321	Rubric based on several graded course tasks

Outcome A Assessment Status: Assessment will begin with ChNE 321 in Spring 2009, and ChNE 361, 461 and 311 in Fall 2009. Data from previous course offerings may be available but have not been compiled yet against these performance criteria.

(B) an ability to design and conduct experiments, and analyze and interpret data.

Performance Criteria	Strategies (Courses)	Sources of Assessment	Assessment Method(s)
1. Plans a laboratory investigation, including the necessary measurements and analysis strategies	ChNE 318, 319, 418, 419	ChNE 319 ChNE 419	Rubric based on performance on pre-Lab report
2. Demonstrates hands-on skills in conducting engineering laboratory experiments	ChNE 318, 319, 418, 419	ChNE 319 ChNE 419	Rubric based on Instructor observation in laboratory
3. Uses scientific and engineering theories and/or correlations to interpret data	ChNE 318, 319, 418, 419	ChNE 319 ChNE 419	Rubric based on performance on laboratory report

4. Estimates and accounts for error and error propagation, and reports measurements and uncertainties appropriately.	ChNE 253, 318, 319, 418, 419	ChNE 319 ChNE 419	Rubric based on performance on laboratory report
5. Explains physical meaning and/or significance of data and observations	ChNE 318, 319, 418, 419	ChNE 319 ChNE 419	Rubric based on performance on laboratory report

Outcome B Assessment Method Details
Assessing with ChNE 319 and 419 will give two sets of data on each student/class.
Criterion 1: Each student normally does the pre-lab report on at least one experiment – that prelab report will be the basis for each student.
Criterion 2: Instructor will observe and assess based on the rubric – may be based on a specific experiment, or be an overall evaluation based on observation throughout the semester.
Criterion 3 - 5: Based on individual reports for team-conducted experiments. Instructor will complete for each student in addition to the normal report grading done for the class. May be based on one particular experiment for the entire class to give uniformity.

Outcome B Assessment Status: Assessment will begin with ChNE 319 and 419 in Spring 2009, and be done each spring. Data from previous course offerings may be available but have not been compiled yet against these performance criteria.

(C) an ability to design processes, systems or components to meet desired needs and subject to realistic constraints, such as economic, environmental, social, political, ethical, health, safety, manufacturability, and sustainability.

Performance Criteria	Strategies (Courses)	Sources of Assessment	Assessment Method(s)
1. Determines size, specifications and cost of major types of chemical process equipment, such as pumps, compressors, heat exchangers, pressure vessels, or distillation columns.	ChNE 312, 321, 493, 494	ChNE 493 ChNE 494	Rubric based on specific assignments or quizzes
2. Utilizes process simulation tool (such as Aspen Plus) to conduct material and energy balances on multi-unit plant subject to constraints	ChNE 253, 321, 493, 494	ChNE 493 ChNE 494	Rubric based on specific assignments or quizzes
3. Identifies important external plant design constraints and factors	ChNE 493, 494	ChNE 493 ChNE 494	Rubric based on design project report
4. Identifies important technical and social constraints related to plant design, construction and operation	ChNE 493, 494	ChNE 493 ChNE 494	Rubric based on design project report

Outcome C Assessment Status: Assessment will begin with ChNE 494 in Spring 2009 and ChNE 493 in Fall 2009. Data from previous course offerings may be available but have not been compiled yet against these performance criteria.

(D) an ability to function on multidisciplinary teams.

Performance Criteria	Strategies (Courses)	Sources of Assessment	Assessment Method(s)
1. Participates actively in team meetings, discussions, and responsibilities	ChNE 101, 318L, 319L, 418L, 419L, 493, 494	ChNE 494	Student peer assessment Instructor observation (rubric)
2. Shares in the work of the team, and completes assigned tasks in a timely fashion	ChNE 101, 318L, 319L, 418L, 419L, 493, 494	ChNE 494	Student peer assessment Instructor observation (rubric)
3. Communicates and interacts effectively with the team	ChNE 101, 318L, 319L, 418L, 419L, 493, 494	ChNE 494	Student peer assessment Instructor observation (rubric)

Outcome D Assessment Status: Assessment will begin with ChNE 494 in Spring 2009. Data from previous course offerings may be available but have not been compiled yet against these performance criteria.

(E) an ability to identify, formulate and solve engineering problems.

Performance Criteria	Strategies (Courses)	Sources of Assessment	Assessment Method(s)
1. Determines what data is given, needed and additional assumptions required to set up an engineering problem	ChNE 312	Final Exam	Rubric
2. Provides visual and verbal descriptions of the operations involved	ChNE 312	Final Exam	Rubric
3. Identify major steps in the solution process, including correlations, equations and algorithms.	ChNE 312	Final Exam	Rubric
4. Describe and present the results in appropriate formats.	ChNE 312	Final Exam	Rubric
5. Discusses methods used to verify the approach selected and the results obtained.	ChNE 312	Final Exam	Rubric

Outcome E Assessment Status: Assessment will begin with ChNE 321 in Spring 2009, and ChNE 361, 461 and 311 in Fall 2009. Data from previous course offerings may be available but have not been compiled yet against these performance criteria.

(F) an understanding of the professional and ethical responsibilities of engineers.

Performance Criteria	Strategies (Courses)	Sources of Assessment	Assessment Method(s)
1. Demonstrates knowledge of the NSPE Code of Ethics	ChNE 451	ChNE 451	• Debate evaluation • Video homework • In-class Scenario Discussion
2. Evaluates the ethical dimensions and dilemmas of a realistic engineering scenario	ChNE 451	ChNE 451	• Debate evaluation • Video homework • In-class Scenario Discussion
3. Locates and utilizes resources for guidance on ethical dilemmas	ChNE 451	ChNE 451	• Debate evaluation • Video homework • In-class Scenario Discussion

Outcome F: Assessment Method Details
Criteria 1-3 will be evaluated by rubric in each of three different in-class activities or deliverables.

Assessment Item 1: Students work in teams in class to discuss and develop positions on ethical scenarios taken from the NSPE Milton F. Lunch Ethics Contest (using the NSPE Code of Ethics as a primary reference). The teams orally present their positions and NSPE Code of Ethics justification. Instructor evaluates contribution from each student based on rubric.

Assessment Item 2: Students watch the video 'Incident at Morales', with unevaluated discussion breaks during the video. Students complete a take-home assignment that addresses situations in the video from several different perspectives.

Assessment Item 3: Students are assigned to "pro" and "con" positions of ethical cases posed and considered by the NSPE Board of Ethical Review (teams of 2 for each position). Debate participation and performance for each student evaluated by Instructor using a rubric.

Outcome F Assessment Status: Assessment done Fall 2008 in ChNE 451 – see next page.

Rubric Results for Performance Criteria Associated with Outcome F

Performance Criteria	Unacceptable (0 points) No of Students	Marginal (1 point) No of Students	Acceptable (2 points) No of Students	Good (3 points) No of Students	Exceptional (4 points) No of Students	Average Rubric Points Score
1. Demonstrates knowledge of the NSPE Code of Ethics.	1		1	19		2.8
2. Evaluates the ethical dimensions and dilemmas of a realistic engineering scenario.				13	8	3.4
3. Locates and utilizes resources for guidance on ethical dilemmas.	1			20		2.9
Overall Average Rubric Point Score						3.0

Basis of Results
PC 1: ChNE 451, Fall 2008 – NSPE Milton Lunch in-class ethics scenario presentations
PC 2: ChNE 451, Fall 2008 – 'Incident at Morales' take home written assignment
PC 3: ChNE 451, Fall 2008 – NSPE BER case study debates

(G) an ability to communicate effectively.

Performance Criteria	Strategies (Courses)	Sources of Assessment	Assessment Method(s)
1. Writes effective full technical reports	ChNE 318L,319L, 418L, 419L, 493, 494	ChNE 494 ChNE 419L	Design report Lab Report
2. Delivers clear and effective oral presentations	ChNE 318L,319L, 418L, 419L, 493, 494	ChNE 451 ChNE 494	Presentation evaluation
3. Utilizes audio-visual presentation aides effectively	ChNE 318L,319L, 418L, 419L, 493, 494	ChNE 451 ChNE 494	Presentation evaluation

Outcome G Assessment Status: Partial Assessment done Fall 2008 in ChNE 451 and ChNE 418L – see next page.

Rubric Results for Performance Criteria Associated with Outcome G

Performance Criteria	Unacceptable (0 points) No of Students	Marginal (1 point) No of Students	Acceptable (2 points) No of Students	Good (3 points) No of Students	Exceptional (4 points) No of Students	Average Rubric Points Score
1. Writes effective full technical reports	0	4	8	7	3	2.4
2. Delivers clear and effective oral presentations	0	2	7	8	4	2.7
3. Utilizes audio-visual presentation aides effectively	0	0	8	8	5	2.9
Overall Average Rubric Point Score						

Basis of Results
PC 1: ChNE 418L, Fall 2008 – Laboratory full technical report grade
PC2: ChNE 451, Fall 2008 – Delivery Score for Technical Talk 2
PC3: ChNE 451, Fall 2008 – Audiovisual Score for Technical Talk 2

(H) an understanding of the global, economic, environmental and societal impacts of engineering activities.

Performance Criteria	Strategies (Courses)	Sources of Assessment	Assessment Method(s)
1. Identifies environmental, safety, and social impacts of chemical plant design and operation.	ChNE 493, 494	ChNE 494	Design reports
2. Knows basic facts associated with historical events and developments in which technology has had a major positive or negative impact.	ChNE 493, 494	ChNE 494	In-class quizzes
3. Makes arguments from multiple perspectives on the impact of current technological developments and issues.	ChNE 451	ChNE 451	Taking Sides debate – instructor evaluation Taking Sides debate – audience evaluation
4. Proposes solution strategies or steps that address possible negative impacts of technological developments.	ChNE 451	ChNE 451	Challenges??

Outcome H: Assessment Details

Assessment of this outcome is based on:

- instructor and audience assessment of student team position presentations of "Yes" and "No" positions associated with readings
- instructor evaluation of individual homework associated with the oral presentations.

Questions addressed in presentation/debates:

- Is it time to revive nuclear power?
- Will hydrogen replace fossil fuels for cars?
- Should potential risks slow the development of nanotechnology?
- Are genetically-modified foods safe to eat?
- Is it ethically permissible to clone human cells?
- Does the spread of surveillance technology threaten privacy?

Outcome H Assessment Status: Partial Assessment done Fall 2008 in ChNE 451 – see next page.

Rubric Results for Performance Criteria Associated with Outcome H

Performance Criteria	Unacceptable (0 points) No of Students	Marginal (1 point) No of Students	Acceptable (2 points) No of Students	Good (3 points) No of Students	Exceptional (4 points) No of Students	Average Rubric Points Score
1. Identifies environmental, safety, and social impacts of chemical plant design and operation.						
2. Knows basic facts associated with historical events and developments in which technology has had a major positive or negative impact.						
3. Makes arguments from multiple perspectives on the impact of current technological developments and issues.			8	12	1	2.7
4. Proposes solution strategies or steps that address possible negative impacts of technological developments.	1		6	14		2.6
Overall Average Rubric Point Score						

Basis of Results
PC 1:
PC2:
PC3: ChNE 451, Fall 2008 – "Taking Sides" in-class debate
PC 4: ChNE 451, Fall 2008 – written position statement

(I) a recognition of the need for lifelong learning and awareness of how this can be achieved in their subsequent career.

Performance Criteria	Strategies (Courses)	Sources of Assessment	Assessment Method(s)
1. Identifies several mechanisms by which lifelong learning can be achieved in an engineering career	ChNE 451	ChNE 451	Quiz/Exam question(s)
2. Elaborates reasons to pursue lifelong learning in an engineering career	ChNE 451	ChNE 451	Quiz/Exam question(s)
3. Locates lifelong learning opportunities on the internet that are relevant for practicing engineers	ChNE 451	ChNE 451	Quiz/Exam question(s)
4. Knows the benefits of licensure and the process for becoming licensed as a Professional Engineer.	ChNE 451	ChNE 451	Quiz/Exam question(s)

Outcome I Assessment Status: Assessment will begin with ChNE 451 in Fall 2009. Data from previous course offerings may be available but have not been compiled yet against these performance criteria.

(J) a knowledge of contemporary issues.

Performance Criteria	Strategies (Courses)	Sources of Assessment	Assessment Method(s)
1. Identifies major contemporary issues that are related to or impacted by engineering activities	ChNE 451, 361	ChNE 451	Grand Challenges – ranking + presentation
2. Evaluates the different facets of complex contemporary issues.	ChNE 451, 361	ChNE 451	
3. Proposes ways that engineers may contribution to better understanding or solution of contemporary issues	ChNE 451, 361	ChNE 451	

Outcome J: Assessment Details

Assessment on this outcome is based on two assignments related to the 2008 Grand Challenges identified by the National Academy of Engineering.

Assessment Item 1: Students read summaries of the 14 Grand Challenges, ranked the top four in their view, and orally explained the reasoning behind their ranking. Instructor assessed the students using a rubric (see attached).

Assessment Item 2: Students were each assigned one of the Grand challenges from their ranked list to use as a topic for a technical oral presentation. Instructor assessed oral presentation using a rubric that included the performance criteria for this outcome, as well as Outcome (G).

Outcome J Assessment Status: Partial Assessment done Fall 2008 in ChNE 451 – see next page.

Rubric Results for Performance Criteria Associated with Outcome J

Performance Criteria	Unacceptable (0 points) No of Students	Marginal (1 point) No of Students	Acceptable (2 points) No of Students	Good (3 points) No of Students	Exceptional (4 points) No of Students	Average Rubric Points Score
1. Identifies major contemporary issues that are related to or impacted by engineering activities			8	17		2.8
2. Evaluates the different facets of complex contemporary issues.				21		3.0
3. Proposes ways that engineers may contribution to better understanding or solution of contemporary issues	Not evaluated	Not evaluated	Not evaluated	Not evaluated	Not evaluated	
Overall Average Rubric Point Score						2.9

Basis of Results
PC 1:ChNE 451, Fall 2008 – Grand Challenge topic rankings
PC2: ChNE 451, Fall 2008 – Grand Challenge oral presentation content score
PC3: Not yet evaluated

(K) an ability to use modern techniques, skills and engineering tools to address problems encountered in engineering practice.

Performance Criteria	Strategies (Courses)	Sources of Assessment	Assessment Method(s)
1. Uses spreadsheet tools in the solution of engineering problems	ChNE 253	ChNE 253	Excel Exam
2. Uses graphing/charting tools	ChNE 253	ChNE 253	Excel Exam
3. Familiar with and able to use a computational/programming platform such as Matlab.	CS 151, ChNE 317, 311	ChNE 317	Assignment
4. Familiar and able to use process simulation tool (Aspen Plus)	ChNE 253, 321, 493, 494	ChNE 253 ChNE 493	Homework (ChNE 493) Exam (ChNE 253)

Outcome K Assessment Status: Assessment will begin with ChNE 253 in Spring 2009, and ChNE 317 and 493 in Fall 2009. Data from previous course offerings may be available but have not been compiled yet against these performance criteria.

Table 3. Nuclear Engineering Program Outcomes and Associated Performance Criteria.

Outcome: (A) an ability to apply knowledge of mathematics, science and engineering to chemical engineering problems

Performance Criteria	Strategies (Courses)	Sources of Assessment	Assessment Method(s)
1. Able to apply mathematics, including algebra, calculus, and differential equations in the formulation and solution of engineering problems.	ChNE 311, ChNE 330, ChNE 310	ChNE 311	Rubric based onl graded course tasks
2. Able to understand and apply physics to nuclear engineering problems.	ChNE 230, 330	ChNE 230	Compton Scattering, Energy Transfer
3. Able to understand and apply engineering fundamentals such as thermodynamics, fluids and heat transport, and materials to the formulation and solution of nuclear engineering problems.	ChNE 314, ChNE 311, ChNE 312, ChNE 313L	ChNE 311, 230	Rubric based on graded course tasks

Outcome A Assessment Status: Assessment will begin with ChNE 311 and ChNE 230 in Fall 2009. Data from previous course offerings may be available but have not been compiled yet against these performance criteria.

Outcome: (B) an ability to design and conduct experiments, and analyze and interpret data.

Performance Criteria	Strategies (Courses)	Sources of Assessment	Assessment Method(s)
1. Plans a laboratory investigation, including the necessary measurements and analysis strategies	ChNE 313L, 323L, 413L	ChNE 323L	Rubric based on performance on pre-Lab report for unknown ID expmt.
2. Demonstrates hands-on skills in conducting engineering laboratory experiments	ChNE 313L, 323L, 413L	ChNE 323L	Rubric based on Instructor observation in laboratory
3. Uses scientific and engineering theories and/or correlations to interpret data	ChNE 313L, 323L, 413L	ChNE 413L	Rubric based on performance on laboratory report for neutron temp expmt.
4. Estimates and accounts for error and error propagation, and reports measurements and uncertainties appropriately.	ChNE 313L, 323L, 413L	ChNE 413L	Rubric based on performance on laboratory report for neutron temp expmt.
5. Explains physical meaning and/or significance of data and observations	ChNE 313L, 323L, 413L	ChNE 413L	Rubric based on performance on laboratory report for neutron temp expmt.

Outcome B Assessment Status: Assessment will begin with ChNE 413L in Spring 2009 and ChNE 323L in Fall 2009. Data from previous course offerings may be available but have not been compiled yet against these performance criteria.

Outcome: (C) an ability to design processes, systems or components to meet desired needs and subject to realistic constraints, such as economic, environmental, social, political, ethical, health, safety, manufacturability, and sustainability.

Performance Criteria	Strategies (Courses)	Sources of Assessment	Assessment Method(s)
1. Determines size, specifications and cost of process equipment, such as pumps, compressors, heat exchangers, or pressure vessels.	ChNE 312	ChNE 312	Rubric (DP3 – pumps)
2. Utilizes Neutron Transport Codes (such as DANT, MCNP, or KENO) to evaluate the neutron behavior in thermal and fast systems	ChNE 498L	ChNE 312	Rubric
3. Identifies important technical and social constraints related to plant design, construction and operation	ChNE 498L	ChNE 312	Rubric

Outcome C Assessment Status: Assessment will begin with ChNE 312 in Spring 2009. Data from previous course offerings may be available but have not been compiled yet against these performance criteria.

Outcome: (D) an ability to function on multidisciplinary teams.

Performance Criteria	Strategies (Courses)	Sources of Assessment	Assessment Method(s)
1. Participates actively in team meetings and discussions	ChNE 498L	ChNE 498L	Students assessing each other
2. Shares in the work of the team, and completes assigned tasks in a timely fashion	ChNE 498L	ChNE 498L	Students assessing each other
3. Demonstrates listening skills, and respect of other members of the team	ChNE 498L	ChNE 498L	Instructor sit in on a team meeting
4. Communicates and Interacts	ChNE 452	ChNE 452	Instructor sit in on a team meeting

Outcome D Assessment Status: Assessment will begin with ChNE 498L and ChNE 452 in Spring 2009. Data from previous course offerings may be available but have not been compiled yet against these performance criteria.

Outcome: (E) an ability to identify, formulate and solve engineering problems.

Performance Criteria	Strategies (Courses)	Sources of Assessment	Assessment Method(s)
1. Determine what data is given, needed and additional assumptions required to set up an engineering problem.	ChNE 312	Final Exam	Rubric
2. Provide visual and verbal descriptions of the operations involved.	ChNE 312	Final Exam	Rubric
3. Identify major steps in the solution process including correlations, equations, and algorithms.	ChNE 312	Final Exam	Rubric
4. Describe and present the results in appropriate formats.	ChNE 312	Final Exam	Rubric
5. Discusses methods used to verify the approach selected and the results obtained.	ChNE 312	Final Exam	Rubric

Outcome E Assessment Status: Assessment will begin with ChNE 312 in Spring 2009. Data from previous course offerings may be available but have not been compiled yet against these performance criteria.

Outcome: (F) an understanding of the professional and ethical responsibilities of engineers.

Performance Criteria	Strategies (Courses)	Sources of Assessment	Assessment Method(s)
1. Demonstrates knowledge of the NSPE Code of Ethics.	ChNE 452	ChNE 452	
2. Evaluates the ethical dimensions and dilemmas of a realistic engineering scenario	ChNE 452	ChNE 452	
3. Locates and utilizes resources for guidance on ethical dilemmas.	ChNE 452	ChNE 452	

Outcome F Assessment Status: Assessment done Spring 2009 in ChNE 452 – see next page.

Rubric Results for Performance Criteria Associated with Outcome F

Performance Criteria	Unacceptable (0 points) No of Students	Marginal (1 point) No of Students	Acceptable (2 points) No of Students	Good (3 points) No of Students	Exceptional (4 points) No of Students	Average Rubric Points Score
1. Demonstrates knowledge of the NSPE Code of Ethics.				7		3.0
2. Evaluates the ethical dimensions and dilemmas of a realistic engineering scenario.				2	5	3.4
3. Locates and utilizes resources for guidance on ethical dilemmas.					7	4.0
Overall Average Rubric Point Score						3.0

Basis of Results
PC 1: ChNE 451, Fall 2008 – NSPE BER case study debates
PC 2: ChNE 451, Fall 2008 – 'Incident at Morales' discussion and NSPE BER case study debates
PC 3: ChNE 451, Fall 2008 – NSPE BER case study debates

Outcome: (G) an ability to communicate effectively.

Performance Criteria	Strategies (Courses)	Sources of Assessment	Assessment Method(s)
1. Writes effective full technical reports	ChNE 313L	Technical Paper	Rubric
2. Delivers clear and effective oral presentations	ChNE 452, 498L	ChNE 452, 498L	Class presentation
3. Utilizes audio-visual presentation aides effectively	ChNE 452, 498L	ChNE 452, 498L	Class presentation

Outcome G Assessment Status: Partial assessment done Spring 2009 in ChNE 452 – see next page.

Rubric Results for Performance Criteria Associated with Outcome G

Performance Criteria	Unacceptable (0 points) No of Students	Marginal (1 point) No of Students	Acceptable (2 points) No of Students	Good (3 points) No of Students	Exceptional (4 points) No of Students	Average Rubric Points Score
1. Writes effective full technical reports						N/A
2. Delivers clear and effective oral presentations			2	3	3	3.0
3. Utilizes audio-visual presentation aides effectively				5	2	3.3
Overall Average Rubric Point Score						

Basis of Results
PC 1:
PC2: ChNE 451, Fall 2008 – Delivery Score for Technical Talk 3
PC3: ChNE 451, Fall 2008 – Audiovisual Score for Technical Talk 3

Outcome: (H) an understanding of the global, economic, environmental and societal impacts of engineering activities.

Performance Criteria	Strategies (Courses)	Sources of Assessment	Assessment Method(s)
1. Identifies environmental, safety, and social impacts of nuclear systems design and operation.	ChNE 498L	ChNE 498L	

Outcome H Assessment Status: Assessment will begin with ChNE 498L in Spring 2009. Data from previous course offerings may be available but have not been compiled yet against these performance criteria.

Outcome: (I) a recognition of the need for lifelong learning and awareness of how this can be achieved in their subsequent career.

Performance Criteria	Strategies (Courses)	Sources of Assessment	Assessment Method(s)
1. Identifies several mechanisms by which lifelong learning can be achieved in an engineering career	ChNE 497	ChNE 497	Paper
2. Elaborates reasons to pursue lifelong learning in an engineering career.	ChNE 497	ChNE 497	Paper
3. Locates lifelong learning opportunities on the internet that are relevant for practicing engineers.	ChNE 497	ChNE 497	Paper
4. Describes the path to and requirements for professional engineering licensure.	ChNE 497	ChNE 497	Paper

Outcome I Assessment Status: Assessment will begin with ChNE 497 in Fall 2009. Data from previous course offerings may be available but have not been compiled yet against these performance criteria.

Outcome: (J) a knowledge of contemporary issues

Performance Criteria	Strategies (Courses)	Sources of Assessment	Assessment Method(s)
1. Identifies contemporary issues related impacted by engineering activities.	ChNE 452	ChNE 452	Rubric
2. Evaluates the different facets of complex contemporary issues.	ChNE 452	ChNE 452	Rubric

Outcome J Assessment Status: Partial assessment done Spring 2009 in ChNE 452 – see next page.

Rubric Results for Performance Criteria Associated with Outcome J

Performance Criteria	Unacceptable (0 points) No of Students	Marginal (1 point) No of Students	Acceptable (2 points) No of Students	Good (3 points) No of Students	Exceptional (4 points) No of Students	Average Rubric Points Score
1. Identifies major contemporary issues that are related to or impacted by engineering activities				6	1	3.2
2. Evaluates the different facets of complex contemporary issues.				6	1	3.2
Overall Average Rubric Point Score						

Basis of Results
PC 1:ChNE 451, Fall 2008 – Grand Challenge topic rankings
PC2: ChNE 451, Fall 2008 – Grand Challenge oral presentation content score
PC3: Not yet evaluated

Outcome: (K) an ability to use modern techniques, skills and engineering tools to address problems encountered in engineering practice.

Performance Criteria	Strategies (Courses)	Sources of Assessment	Assessment Method(s)
1. Uses spreadsheet tools in the solution of engineering problems	ChNE 317	ChNE 317	Rubric
2. Uses graphing/charting tools	ChNE 317	ChNE 317	Rubric
3. Familiar with and able to use a computational/programming platform such as Matlab.	ChNE 317	ChNE 317	Rubric
4. Familiar and able to use neutron transport codes (DANT, KENO)	ChNE 497	ChNE 497	Rubric with comparison of Dant and Keno (DP9)

Outcome K Assessment Status: Assessment will begin with ChNE 317 and ChNE 497 in Fall 2009. Data from previous course offerings may be available but have not been compiled yet against these performance criteria.

Assessment of Graduate Programs
The School of Engineering has recently developed educational outcomes for M.S., M.Eng., and Ph.D. within the school, and rubrics to be utilize by the graduate examination committees in assessing these outcomes (see forms below). The department intends to apply these outcomes and assessment rubrics, but has not begun implementation.

Outcomes for SOE Graduate Degree Programs:
Ph.D. Programs
Students receiving the PhD in Engineering will:

1) Exhibit knowledge of engineering and science fundamentals appropriate for the discipline and/or specialization.

2) Demonstrate a depth of knowledge in the specialization.

3) Have the ability to conduct independent research.

4) Have demonstrated the ability to perform a critical review of the literature in the area of specialization.

5) Be able to communicate effectively.

M.S. and M.Eng. Programs
Students receiving Masters degrees from the School of Engineering will:

1) Exhibit knowledge of engineering and science fundamentals appropriate for the discipline and/or specialization.

2) Be able to communicate effectively.

3) Demonstrate the ability to critically assess information in the discipline and/or specialization.

Assessment Plans:
Ph.D. programs For students receiving a Ph.D. from the School of Engineering, the student's exam committee will assess whether the student has achieved the SOE outcomes based on the student's dissertation and defense. This will be documented on a rubric that has been developed for this purpose, to be filled out by a consensus of the committee (rather than by each individual member of the committee).

M.S. and M.Eng. programs For M.S. or M.Eng. students, assessment will be done using the exit exam given by each department to assess outcome 1. For outcomes 2 ad 3, an example of independent work such as a term paper, project, etc. will be solicited from each student. A rubric will be to assess these outcomes.

Results of the outcomes assessment for each student will be evaluated by each department's graduate committee and/or faculty. The evaluations prepared by each departmental graduate committee will be reported to the SOE graduate committee for analysis, discussion, feedback, and any necessary action.

SOE Ph.D. Outcomes Assessment Rubric

To be filled out by committee chair in consultation with exam committee.

Student: _____ Date: _____

Outcome	Unacceptable (0)	Marginal (1)	Acceptable (2)	Exceptional (3)	Rating
1) Knowledge of engineering/science fundamentals appropriate for discipline and specialization	No evidence of PhD level fundamental knowledge.	Rudimentary knowledge exhibited in written document and oral presentation.	Knowledge of fundamentals evident in written and oral presentation.	Demonstrates mastery of appropriate fundamentals for the discipline.	
2) Depth of knowledge in specialization	Only rudimentary knowledge in specialization.	Some knowledge of specialization evidenced.	Demonstrates appropriate level of knowledge in specialization.	Demonstrates knowledge of specialization comparable to experienced practitioner.	
3) Ability to conduct original research	No evidence of planning and execution of research program.	Some useful research results with some evidence of original work.	Carried out good research program, achieved useful and novel results.	Excellent planning and execution of research program. Excellent results	
4) Ability to perform critical review of literature in area of specialization	Rudimentary literature review.	Some review of the literature, but little critical evaluation.	Comprehensive review of literature with evidence of critical thinking about further needs for research in this area.	Extensive review of literature with critical evaluation comparable to a review article in literature.	
5) Able to communicate effectively	Dissertation/thesis poorly written. Oral exam not well planned or presented. Unable to answer questions.	Dissertation/thesis mostly clearly written. Presented main points clearly. Able to answer most questions.	Well written and well organized dissertation/thesis. Well organized and clear presentation. Good ability to answer questions.	Excellent job of writing and organizing dissertation/thesis. Well organized talk. Able to respond to questions and facilitate further discussion of results.	
Overall Assessment	**Unacceptable (1)**	**Marginal (2)**	**Acceptable (3)**	**Exceptional (4)**	

Comments:

What curricular or process changes can you suggest to improve student performance in these areas?

_____

Masters Degree Outcomes Assessment Rubric

To be completed by chair of student's exam committee in consultation with committee, or by assessment committee appointed by department chair.

Student: _____ Date: _____

Outcome	Unacceptable (0)	Marginal (1)	Acceptable (2)	Exceptional (3)	Rating
1) Knowledge of engineering/science fundamentals appropriate for discipline and specialization	No evidence of Masters level fundamental knowledge.	Rudimentary knowledge exhibited in written document and oral presentation.	Knowledge of fundamentals evident in written and oral presentation.	Demonstrates mastery of appropriate fundamentals for the discipline.	
2) Ability to communicate effectively	Document poorly written.	Document mostly clearly written. Presented main points clearly.	Well written and well organized document.	Excellent job of writing and organizing document discussion of results..	
3) Ability to perform critically assess information in discipline/ specialization	Rudimentary review of disciplinary information..	Some review of disciplinary information, but little critical evaluation.	Comprehensive review of disciplinary information with evidence of critical thinking about further needs for research in this area.	Extensive review of disciplinary information with critical evaluation comparable to a review article in literature.	
Overall Assessment	**Unacceptable (1)**	**Marginal (2)**	**Acceptable (3)**	**Exceptional (4)**	

Comments:

What curricular or process changes can you suggest to improve student performance in these areas?

4. Institutional Contributions

The Department of Chemical and Nuclear Engineering does not offer undergraduate courses that are utilized to any sizeable degree by other majors or departments. However, at the graduate level, we do offer a number of crosslisted courses with other departments, and provide major support for several interdisciplinary graduate programs.

Chemical Engineering

Chemical engineering professor Abhaya Datye is the Director of an interdisciplinary Ph.D. program in Nanoscience and Microsystems (NSMS). That program has its own support staff, and is scheduled to undergo its own UNM program review. The program has a large overall listing of courses involving faculty from several departments. Professors Abhaya Datye and Jeff Brinker regularly contribute to teaching of core courses in that curriculum, a number of other chemical engineering faculty contribute to elective courses in that curriculum, all of which are cross listed.

A listing of ChNE/NSMS cross-listed courses follows.

- CHNE /NSMS 512: Characterization Methods for Nanostructures
- CHNE/NSMS 511: Synthesis of Nanostructures
- CHNE/NSMS 522L: Fundamentals of Nanofluidics
- CHNE /NSMS 530: Surface and Interfacial Phenomena
- CHNE /NSMS 533: Vapor and Aerosol Phase Material Processing
- CHNE /NSMS 538: Biosensors Fundamentals and Applications
- CHNE /NSMS 550: Social and Ethical Issues in Nanotechnology
- CHNE /NSMS 575: Polymer Science and Engineering

Other Crosslisted courses supported by chemical engineering faculty include:

- CHNE/ME 405/505: High Performance Engines

A proposal to develop a graduate (M.S. and Ph.D.) program in Biomedical Engineering is currently being led by chemical engineering Prof. Gabriel Lopez. This program will be voted on soon by the School of Engineering faculty, and will rely in part on faculty and staff from the department. The intent is that overall teaching obligations in that program will be included as part of normal department work load expectations.

Nuclear Engineering

The nuclear engineering program offers a Plan II (non-thesis) M.S. concentration in Medical Physics that requires courses from ChNE and Medical Physics, which is associated with the Department of Radiology in the UNM School of Medicine. The program is administered through ChNE. ChNE course that are part of that interdisciplinary program include:

- ChNE 523 L Environmental Measurements Laboratory – 3 cr
- ChNE 524 Interaction of Radiation with Matter – 3 cr
- ChNE 528 External Radiation Dosimetry – 3 cr
- ChNE 529 Internal Radiation Dosimetry - 3 cr

Other cross-listed courses that have primarily supported by nuclear engineering faculty include:

- CHNE/CE 439/539: Radioactive Waste Management
- CHNE/ASTR/PHYC/ECE 534: Plasma Physics I
- CHNE/ECE 546: Charged Particle Beams
- CHNE/ECE 553L: Experimental Techniques in Plasma Science
- CHNE/ECE 555: Gaseous Electronics
- CHNE/PHYC/ECE 580: Advanced Plasma Physics

5. Student Profile and Support Data

Undergraduate Admissions and Advisement (Both Programs)

Incoming freshmen that are interested in engineering may either be admitted to the School of Engineering as pre-majors (if they score well on the admissions exam which places them in the higher-level English and Mathematics courses) or to University College. After they meet certain requirements in University College, they too will acquire pre-major status. Students receive general advising from the Engineering Student Programs Office of the School of Engineering. Once students complete their first year math, physics and chemistry courses, they are eligible to apply for admission into chemical engineering, typically in their second semester on campus. They have to meet certain criteria (such as GPA) to be eligible to transfer into the Department. A central role is played by the Program Advisement Coordinator who helps students prepare their application for admission, and counsels students on transfer classes and on meeting the requirements for admission.

After a student is admitted into the Department (typically in their sophomore year), they meet with the Undergraduate Advisor who discusses with each student their goals and interests, career options, the curriculum and concentrations, and requirements for graduation. Incoming students are initially advised by the undergraduate advisor. In nuclear engineering, the undergraduate advisor continues advising all students. In chemical engineering, once a student has decided on his or her area of concentration, advisement is transferred to a faculty member whose research interests are in that concentration area. This faculty member is knowledgeable in the appropriate electives for this concentration, on career and research opportunities in this field, and hence can serve as faculty mentor and advisor until the student graduates. Every semester, the students in both programs meet with their designated advisor and fill out an advisement questionnaire that lists the courses they are currently taking and those planned for the next semester. The student discusses the program of study with their faculty advisor who makes sure that the student is following an appropriate program of studies and is making progress towards the degree. Once the advisor approves, the work sheet goes to the Program Advisement Coordinator who makes an overall consistency check before releasing the advisement hold for each student. This proactive approach to advising every semester has helped us keep students on track, with an average time to graduation of less than 3 years after admission to the department (both undergraduate programs).

Undergraduate Enrollments

The department currently has 96 enrolled undergraduates (60 ChE/ 36 NE), and undergraduate enrollment trends are shown in Fig. 2. Undergraduate enrollments in the chemical engineering undergraduate program have been on the upswing since 2005 and continue to grow. Nuclear engineering undergraduate enrollments have also been strong in recent years for our program, and are currently growing. The trends in B.S.

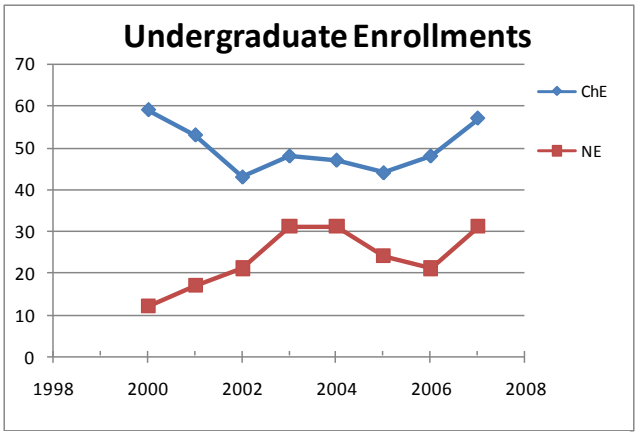


Fig. 2. Undergraduate enrollment trends in chemical engineering and nuclear engineering

degrees awarded and student credit hours are shown in Figs. 2 and 3. The increased enrollments are bringing the numbers of B.S. degrees awarded each year to historically high levels for the NE program (>10), and to historically strong levels for the ChE program (>20). As chemical engineering classes become larger than 20-25, we are finding that our laboratories and senior seminar class need to utilize two sections. Similarly, the space in the nuclear engineering laboratory will mandate split sections as enrollments grow.

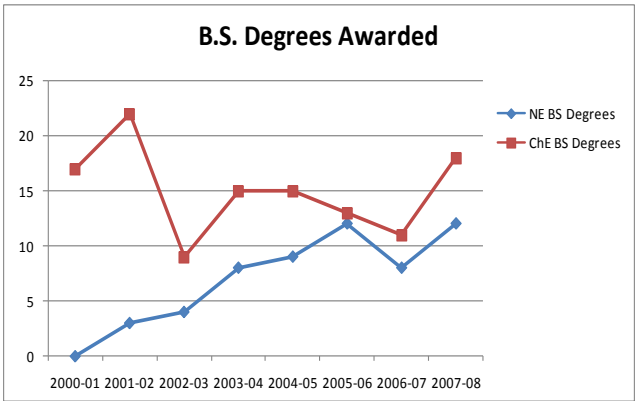


Fig. 3. Trends is B.S degrees in chemical engineering and nuclear engineering

The department is proud of the high level of minority and female representation in our student population. The chemical engineering undergraduate program is characterized by approximately 45% minority students (largely Hispanic), and 55% female. The nuclear engineering undergraduate population is approximately 35% minority and 45% female.

Our aggressive advisement procedures have resulted in an average time-to-degree of less than 3 years after entrance to the School of Engineering for B.S. graduates in both programs

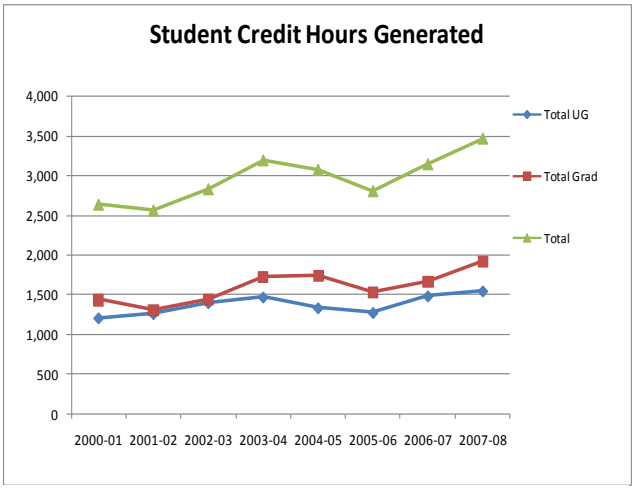


Fig. 4. Trends in student credit hours in chemical engineering and nuclear engineering

The enrollment trends in undergraduate and graduate programs have led to substantial growth in student credit hours generated for the department from ~2500 in 2001-2002 to ~3500 in 2008-09, and steady growth over the past 3-4 years.

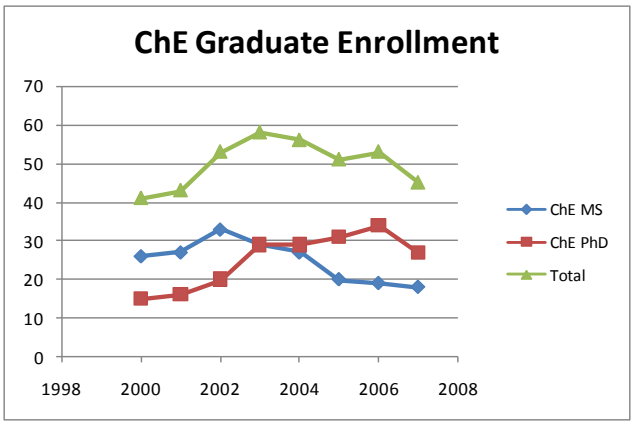


Fig. 5. Trends in graduate enrollment in the chemical engineering grad program.

Graduate Admission and Enrollments

Graduate enrollments in chemical engineering have seen a significant rise in Ph.D. relative to M.S. enrollments in the last 8 years, with a slight overall decrease over the past 4-5 years (Fig. 5). This decrease is probably attributable to some lag associated with the startup of four new assistant professors (whose groups we expect to grow), and some "crossover" to the NSMS Ph.D. program, which is administered separately. Nuclear engineering graduate enrollments have been growing steadily for the past 7years, with recent growth in M.S. degrees partially driven by the successful Medical Physics M.S. program (Fig. 6).

Among the graduate students, chemical engineering graduate students are approximately 35% minority and 30% female; and nuclear engineering graduate students are approximately 20% minority and 10% female.

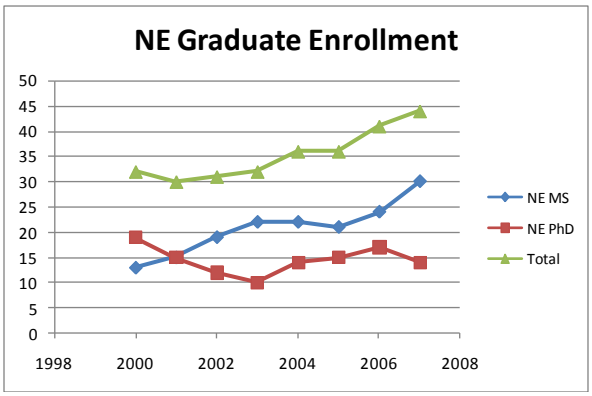


Fig. 6. Trends in graduate enrollment in the nuclear engineering grad program.

Table 4, and Figs. 7 and 8 display some data related to graduate applications and admissions in the chemical and nuclear engineering programs. One very apparent trend that jumps out, especially for the chemical engineering program is the large drop in applications that occurred between in the 2000-2004 time period. This has been slowly improving, and applications are up considerably in 2008-2009. It is also noted for the chemical engineering program that, after years of near parity in M.S. and Ph.D. admissions, Ph.D. admissions are now exceeding M.S. admissions. We view this as a desirable trend for the long-term research stature of the program. For the nuclear engineering program, there is also an on-going issue of relatively few Ph.D. applicants, though M.S. applicants have surged in recent years. For both programs, attention to graduate recruiting is currently a high-priority task, especially given the number of junior faculty building their research programs at the moment.

Table 4. Summary of application and admission data for the chemical and nuclear engineering graduate programs.

	2000		2001		2002		2003		2004		2005		2006		2007	
	CHE	NE	CHE	NE	CHE	NE	CHE	NE	CHE	NE	CHE	NE	CHE	NE	CHE	NE
Masters																
Applied	56	10	45	4	49	10	24	7	16	5	14	6	10	12	13	23
Admitted	17	6	5	3	9	7	4	4	2	2	7	5	7	12	4	14
% Admitted	30%	60%	11%	75%	18%	70%	17%	57%	13%	40%	50%	83%	70%	100%	31%	61%
Doctoral																
Applied	39	8	26	4	22	5	23	7	6	4	7	2	12	0	24	3
Admitted	12	2	5	0	7	2	2	6	4	3	5	2	8	0	9	3
% Admitted	31%	25%	19%	0%	32%	40%	9%	86%	67%	75%	71%	100%	67%	0%	38%	100%
Total																
Applied	95	18	71	8	71	15	47	14	22	9	21	8	22	12	37	26
Admitted	29	8	10	3	16	9	6	10	6	5	12	7	15	12	13	17
% Admitted	31%	44%	14%	38%	23%	60%	13%	71%	27%	56%	57%	88%	68%	100%	35%	65%
Dept Totals																
Applied	113		79		86		61		31		29		34		63	
Admitted	37		13		25		16		11		19		27		30	
% Admitted	33%		16%		29%		26%		35%		66%		79%		48%	

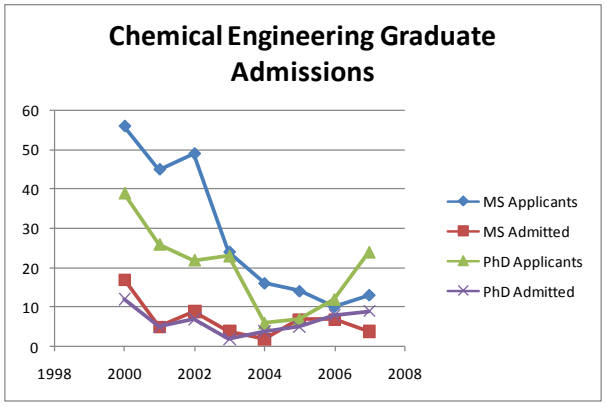


Fig. 7. Graduate applications and admissions in the nuclear engineering grad program.

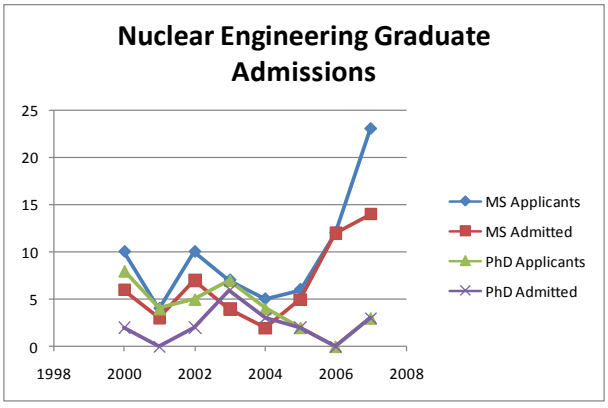


Fig. 8. Graduate applications and admissions in the nuclear engineering grad program.

6. Faculty Matters

The total number of tenure/tenure-track faculty grew to 18 for the 2008-09 academic year (Table 2). The increase in total number of faculty has been accomplished through retirements (replacing higher salaried senior faculty with lower salaried Assistant Professors), through co-funding with Idaho National Laboratory (de Oliveira), and through state funding for a new biomedical engineering graduate program (Graves). In the past five years there have been four retirements in the chemical engineering program and one in nuclear engineering. With most new hires coming in at the Assistant Professor level, the percentage of tenured faculty has decreased from 87% in 2002 to 61% currently. During that period the number of female faculty also doubled from 2 to 4, making our faculty currently 22% female.

Table 5. Statistics on tenure/tenure track faculty for the Department of Chemical and Nuclear Engineering (statistics include Prof Fulghum, now Vice President for Research)

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Tenure/Tenure-Track Faculty	14	15	15	16	16	16	15	15	18
Number Tenured	12	13	13	13	13	13	11	11	11
Percent Tenured	85.7	86.7	86.7	81.2	81.2	81.2	73.3	73.3	61.1
Asian/Pacific Islander	2	2	2	3	3	4	4	4	5
Hispanic	1	1	1	1	1	1	1	1	1
White Non-Hispanic	11	10	12	11	11	11	9	10	12
Female	1	1	2	2	2	3	3	3	4
Lecturers	1	1	1	1	1	1	1	1	2

The five faculty additions in the last five years in the chemical engineering program (Canavan, Dirk, Petsev, Chi, Graves) have been largely made to strengthen the biomedical and biomolecular research strength of the department. This was coupled with a committed effort by the Dean of Engineering to secure state funding for development of biomedical engineering research at UNM, which led to the formation of the Center for Biomedical Engineering (CBME), directed by Gabriel Lopez. In the nuclear engineering program, new faculty additions were made in the area of multiphysics computational methods, for which a senior person was hired (de Oliveira), and a junior person (Hecht) was hired to help develop new strategic areas related to nuclear nonproliferation and nuclear medicine.

The department also currently relies on two Lecturers to support the teaching mission. In addition, the department relies on Adjunct Professors to teach some courses. In some cases Research Professors teach, but Research Professors (all levels) are generally focused on research and supported by external grants. A listing of tenure-track faculty and other regular teaching faculty is provided below, and 2 page vitae are provided in Appendix C.

Chemical Engineering Tenured or Tenure-Track Faculty

Professor

C. Jeffrey Brinker, (Ph.D., 1979, Rutgers University), Distinguished and Regents Professor

Joseph L. Cecchi, (Ph.D., 1972, Harvard University), Professor and Dean of Engineering

Abhaya K. Datye, (Ph.D., 1984, University of Michigan), Distinguished Professor and Director of CMEM and the NSMS graduate program
Julia E. Fulghum, (Ph.D., 1987, University of North Carolina), Professor and Vice President for Research
Gabriel P. López, (Ph.D., 1991, University of Washington), Professor and Director of CBME
Timothy L. Ward, (Ph.D., 1989, University of Washington), Professor and Chair

Associate Professor
Plamen Atanassov, (Ph.D., 1992, Bulgarian Academy of Science), Associate Professor and Director of CEET
Sang. M. Han, (Ph.D., 1998, University of California-Santa Barbara), Associate Professor
Steve Graves (Ph.D., 1998, The Pennsylvania State University), Associate Professor

Assistant Professor
Heather Canavan, (Ph.D., 2002, George Washington University), Assistant Professor
Eva Chi (Ph.D., 2004, Unversity of Colorado), Assistant Professor
Elizabeth L. Dirk (Ph.D., 2004, Rice University), Assistant Professor
Jeremy Edwards, (Ph.D., 1999, University of California, San Diego), Assistant Professor, Molecular Genetics & Microbiology and ChE (0.1 FTE in ChE)
Dimiter N. Petsev, (Ph.D., 1996, University of Sofia), Assistant Professor

Lecturer
Eric Carnes (Ph.D., 2008, University of New Mexico), Lecturer II

National Laboratory Professors
John G. Curro, (Ph.D., 1969, California Institute of Technology), UNM/NL Professor, ChE
Ronald E. Loehman, (Ph.D., 1969, Purdue University), UNM/NL Professor, ChE

Nuclear Engineering Tenured or Tenure-TrackFaculty
Professor
de Oliveira, Cassiano, (Ph.D., 1986, Queen Mary College, University of London), Professor
Mohamed S. El-Genk, (Ph.D., 1978, University of New Mexico), Professor and Director of ISNPS
Anil K. Prinja, (Ph.D., 1980, University of London), Professor, Associate Chair and Associate Director of CNNST

Associate Professor
Gary W. Cooper, (Ph.D., 1976, University of Illinois), Associate Professor

Assistant Professor
Taro Ueki, (Ph.D., 1998, University of Michigan), Assistant Professor
Adam Hecht (Ph.D., 2004, Yale University), Assistant Professor

Lecturer
Robert D. Busch, (Ph.D., 1976, University of New Mexico), Lecturer III

The department also utilizes Adjunct Faculty, Emeriti Faculty, Research Faculty or faculty with from other departments with secondary appointments in ChNE to teach some courses where their expertise fits particularly well. This is particularly true in the nuclear engineering program where the number of faculty are stretched to cover the curriculum and the Radiation Protection and Medical Physics. In the current academic year, the following courses have been taught by instructors outside the department regular faculty:

Dr. Glenn Taylor, Chemical Engineering Design

Dr. Norm Roderick, ChNE 525, Methods of Analysis in Chemical and Nuclear Engineering; ChNE 534 Plasma Physics I

Dr. Jean-Michel Tournier, ChNE Thermodynamics and Nuclear Systems

Dr. W. Gill, ChNE 372 Nuclear Materials Engineering

Dr. F. Ghanbari, ChNE 499/515 WMD and Nonproliferation

Dr. Phil Heintz, ChNE 527, Radiation Biology; ChNE 516/517L Medical Imaging I

Dr. Lloyd Brasure, ChNE 466, Nuclear Environmental Safety Analysis

Dr. Patrick McDaniel, ChNE 524 Interaction of Radiation with Matter

Dr. Charles Kelsey, ChNE 527 Radiation Biology

Faculty Teaching and Workload

There is a 3-5 year teaching plan for each of the programs that is used to balance teaching loads, plan teaching transitions, ensure coverage for sabbaticals and absences, etc. We typically expect to see teaching duties for a course change every 3-5 years, but many factors end up affecting that, including the preferences of the faculty member.

The faculty workload takes into consideration teaching, research, student mentoring and service. A "typical" faculty workload (if such a thing exists) would include the following:

- ~2.5-3 courses per year (partial credit for courses with less than 3-credits)
- Research active with grad student/post doc advisory responsibilities
- Service – credit here varies by the demands of the task
- Credit for administrative burden, such as very large group, center director, or academic program director.
- Credit for salary "release time" paid from grants or contracts.

Because of the smaller size of the nuclear engineering faculty, the use of Adjuncts Professors helps to keep down teaching loads. We try to limit new faculty teaching loads to no more than 2 courses in the first year. In addition, we try to arrange for shared responsibility in the first year,

with the previous instructor co-teaching and mentoring, followed by transition to sole responsibility in the second year. Service expectations are also lower for untenured faculty.

Faculty Research and Scholarly Work

All tenured or tenure-track faculty are expected to maintain a respectable level of scholarly output that is appropriate for their rank and other workload factors. Scholarly work, of course is a critical part of successful tenure, but also factors into workload considerations and annual evaluations for faculty at all levels. For most, this means establishing a funding base that is appropriate for their area and desired group size, publication, advisement and matriculation of graduate students, and other scholarly service such as proposal panel service, conference and workshop leadership, etc.

The centers affiliated with the department (Center for Microengineered Materials (CMEM), Center for Biomedical Engineering (CBME), Center for Emerging Energy Technologies (CEET), Institute for Space and Nuclear Power Studies (ISNPS), and the Center for Nuclear Nonproliferation Science and Technology (CNNST)) play a major role in the research environment and productivity of the department's faculty. An accurate measure of research expenditures for the department faculty requires that the expenditures of the department centers also be considered, since the majority of contributors to those centers are ChNE faculty. Fig. 9 shows the overall research expenditures for the department and affiliated centers since 2003/2004. The majority of these expenditures are derived from departmental regular and research faculty. Total expenditures have grown from just over $4MM in 2005-2006 to over $6 MM in 2007-2008. The growth in research expenditures is happening through CMEM and the recently established CBME. With the addition of four new faculty in the areas biomedical engineering and materials in the past 4 years, we expect to see this growth trend continue . The recent establishment of CEET should also contribute to growth in energy related research programs. It is also expected that, with the addition of two new faculty in the nuclear engineering program, that we should see growth of research expenditures there as well.

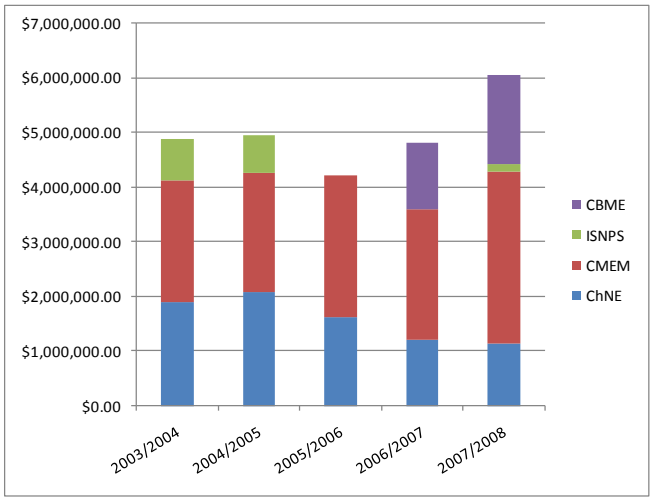


Fig. 9. Research expenditures for ChNE and its affiliated centers.

It must be noted that the expenditure growth through the centers has come at the expense of expenditures in the department accounts, reducing overhead return revenue to the department. Since the department relies on overhead return to support faculty startup, and partially augment state funding for basic operation of the department, this loss of overhead return to the department is having a negative impact on the financial operations of the department – this is discussed further in Section 7 below.

Table 6 and Fig. 10 below show aggregate data for the number of referred journal publications of the department faculty. It must be noted that approximate 1/3 (7/22) faculty included in the presented aggregate numbers are Assistant Professors or Lecturers with relatively short track records.

Table 6. Numbers of refereed journal publications by faculty (based on 22 faculty, which includes 18 tenure/tenure-track faculty, 2 National Laboratory Professors and 2 Lecturers).

	Total	Last five years
Aggregate Number of Publications	1686	504
Average/Faculty Member	70.25	21

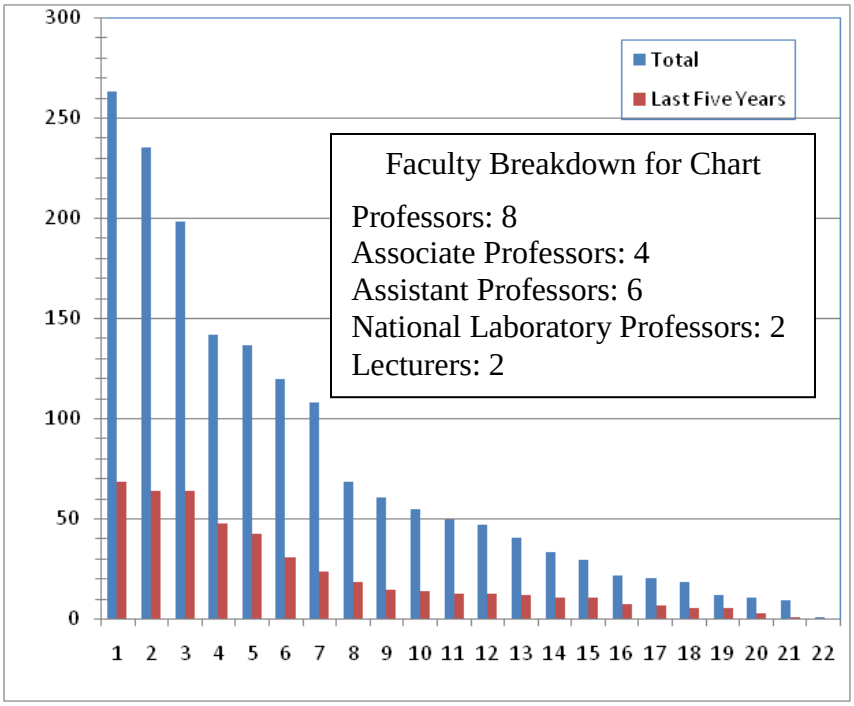


Fig. 10. Distribution of faculty publication numbers for refereed journal publications only - total and last five years.

7. Resource Bases

Facilities and Support Staff

The department has outstanding staff support, with 7 full-time staff, including a department administrator, an accountant, a program advisement coordinator, graphic designer, administrative assistant, facilities service manager (in charge of nuclear engineering undergraduate laboratory) and a research engineer (in charge of the chemical engineering undergraduate laboratory). The department also benefits from staff in the Center for Micro-engineered Materials and the Center for Biomedical Engineering. The staff resources have been stable over the past five years. They are supplemented by work study student help.

The department main office and most faculty offices are housed on the second floor of Farris Engineering Center. Several department faculty with biomedical research interests have their offices in the new Centennial Engineering Center, where the Center for Biomedical Engineering is housed. Research laboratories are located in the basement of Farris Engineering Center and Centennial Engineering Center (biomedical engineering).

There are no classrooms specifically dedicated to the department, and none available within the Farris Engineering Center building. The university has a process for scheduling classrooms that generally works well, and most classes are scheduled in adequate rooms in adjacent buildings (normally the Mechanical Engineering building or Centennial Engineering Center). The department has scheduling control over one seminar room, and two other seminar rooms are accessible in Farris. There is also a large well-equipped auditorium in Centennial Engineering Center that can be scheduled through the School of Engineering. The University maintains computer-equipped classroom facilities in a nearby building that are available for courses involving teaching of software use, or interactive computer use with the instructor. A 30-seat computer classroom, with all new computers and high-quality projection, is also available (through central scheduling) in the Mechanical Engineering building. Classroom facilities are adequate for accomplishment of our objectives, though scheduling sometimes requires use of classrooms that are some distance from the department. Technology is minimal in most classrooms (exceptions being the ITV classrooms and special computer classrooms), so that projectors and computers must typically be hauled to and from class if needed.

Libraries

The University Libraries (UL) is a member of the Association of Research Libraries, and is composed of four separate facilities on the University of New Mexico's main campus in Albuquerque: Zimmerman Library (education, social sciences, and humanities); Centennial Science and Engineering Library (CSEL); Parish Memorial Library (business and economics); and the Fine Arts and Design Library.

The four branches of the UL hold over 2 million print volumes in their collections. The UL currently has over 8,000 subscriptions to print journals and nearly 17,000 subscriptions to electronic journals in all disciplines. There are numerous special collections in the UL, including Department of Energy Technical Reports and the Map and Geographic Information Center (MAGIC) at Centennial Library.

The UL provides 24/7 remote access to electronic journals, electronic reference sources and other books, over 300 electronic databases, and the library catalog (LIBROS) of print holdings. The Department of Chemical and Nuclear Engineering is truly interdisciplinary and the library has numerous resources to support the research and instruction needs of the Department. Most of the journals and all of the indexing and abstracting databases are available electronically, both on campus and remotely. The most important databases we provide are CompendexPlus (all the world's engineering literature from 1884 to the present), SciFinder Scholar (the world's chemistry literature from 1904 to the present), Biosis (life sciences literature from 1926 forward), and US and International databases of information on nuclear energy. There are also journals, both print and online, including all of the journals from the American Institute of Chemical Engineers, and the American Chemical, Nuclear, and Physical Societies.

The Chemical and Nuclear Engineering librarian provides specialized assistance to the department by selecting books and journals for the library's collections, handling in-depth reference questions directly for any students, faculty, and staff, and providing library instruction tailored at all levels, including beginning students enrolled in ChNE 101 and graduate students enrolled in the research methods class ChNE 502.

Additional reference support is provided by all CSEL librarians via the reference desk, which is staffed in person, by phone, and by e-mail over 50 hours per week.

Chemical Engineering Laboratories

Our undergraduate laboratories are located in the new Centennial Engineering Center. The Centennial Engineering Center opened in Fall 2008. The lab courses and experiments are now designed to couple with specific lecture classes, and are taken the semester after the related lecture class. The students conduct a collection of team-based experiments that reflect a mix of traditional fundamental experiments and new experiments that relate to new evolving technologies. The list of current experiments utilized in the laboratory sequence is given in Table 7. We intend to continue updating laboratory experiments, subject to financial constraints. There are currently plans to develop four new experiments, two based on commercially-available turn-key experimental systems, and two that would be developed in-house based on our existing research programs. The proposed new commercial experiments would address thermodynamics power cycles, enzymatic catalysis/reaction engineering, and cost in the range of $20 - $40K each. The planned in-house experiment developments are in the areas of fuel cells and cellular kinetics. We are currently limited by resources for new experiment development, but intend to explore grant opportunities and other funding sources to enable these improvements. Undergraduate laboratories are supported by one full-time staff member for each program, which has been adequate for our enrollments.

Nuclear Engineering Laboratory and Facilities

Our undergraduate laboratories are located in the Nuclear Engineering Laboratory. In addition, our students do 3 experiments in the Undergraduate Chemical Engineering Laboratory. The lab courses provide background in Nuclear Detection and Radiation Measurement, Neutronics, Fluid Flow and Heat Transfer, and Nuclear Reactor Operations. Table 8 shows the courses with their associated experiments.

Electronic equipment in the nuclear engineering lab is currently adequate, but we are down to the minimal number of some pieces of equipment (counter/timers, amplifiers, pre-amplifiers in

particular). Replacement and modernization of equipment is limited by financial resources, which are very tight at the department level. Grant opportunities are being pursued to enhance the laboratory equipment deficiencies. A new non-proliferation for undergraduates is also being planned, and a grant proposal has been submitted that would help implement this.

Table 7. List of Teaching Experiments for Undergraduate Chemical Engineering Laboratories

FLUID FLOW EXPERIMENTS	HEAT TRANSFER EXPERIMENTS	MASS TRANSFER EXPERIMENTS
Tank Efflux	Thermal Conduction	Distillation (Batch & Continuous)
Friction in Fittings	Water DP Heat Exchanger	Wetted Wall Column
Packed & Fluidized Beds		
CHEMICAL KINETICS	**PROCESS CONTROL**	**THERMODYNAMICS**
Gaseous PFR	Level Control	Vapor-Liquid Equilibrium
Glucose/Enzyme Kinetics		Liquid-Liquid Equilibrium
		Heat of Combustion

Table 8. Summary of nuclear engineering undergraduate laboratory experiments

ChNE 230 – Fall sophomore year	Multi-Isotope Half Life Determination
	Radiation Safety and 1/R-squared measurements
ChNE 231 – Spring sophomore year	Nuclear Reactor Kinetics Demonstration
ChNE 213 – Spring sophomore year	Oscilloscopes and Basic Detection Circuits
ChNE 323L – Fall junior year	Counting Statistics
	Electronics and Lab Instrumentation
	Geiger-Mueller and Short Half-Life
	Gas Flow Proportional Counters and Dead Time
	Scintillation Detectors
	Gamma Spectroscopy
	Alpha Spectrometry
	Unknown Isotope Identification
ChNE 313L – Spring junior year	Radiation Buildup and Decay
	Neutron Detectors
	Fermi-Age Measurements
	Friction in Fittings Fluid Flow
	Steady-State and Unsteady-State Conductive Transfer
	Double Pipe Heat Exchangers
ChNE 413L	Introduction to UNM AGN-201M NuclearReactor
	Approach to Critical Measurements
	Reactor Kinetics, Positive, Negative Periods, Rod Drops
	Importance Functions
	Neutron Temperature
	Flux Mapping
	Power Calibration
	PWR Power Plant Simulator

Most of the experiments are performed in teams of two or three students with each student responsible for the analysis and write-up of the experiments. The NE Undergraduate laboratory is supported by one full-time staff member.

Computational Facilities

The computing services of the University are provided by a centralized network. A large university maintained "pod" is located adjacent to Farris Engineering Center. The University also provides excellent consulting services for all students and has quality people to solve system and hardware problems. In addition to those facilities, the department maintains its own computer "pod." The computers, monitors and furniture have been completely replaced in the last several years. Students have access to these computers 24 hours a day, and the Department is responsible for the upgrades and maintenance of the computers, as well as software installation and maintenance. The departmental pod generally satisfies the day-to-day needs of our students, and students are increasingly using their laptops since wireless access has been improved markedly in recent years.

Table 9 below summarizes the software that is available on the department computers. Most of these are installed on a department-maintained server and accessed via a license server. This software represents what we feel is needed to adequately service our curriculum. A variety of university-licensed software can also be accessed by students through the university network.

Table 9. Software available on the department computer facilities.

System Tools	Norton Anti-Virus, Adobe Acrobat Reader
Network Tools	M.S. Internet Explorer, FTP, Telnet
Numerical methods	Comsol Multiphysics
Word Processing	M.S. Word
Presentation	Powerpoint
Symbolic Manipulator	Mathematica, MatLab
Graphics	Mathematica, M.S. Excel
Spread sheets	M.S. Excel
Simulators	Aspen Engineering Suite
Vendor's Software	Taconet, Pumpsel, Gould's Pump Selector

Financial Operations

The department budget is determined by the administration, based on institutional funding allocated by the State Legislature and funding derived from student tuition. Budgets and raises over the past few years have been flat or seen small increases. The department Instruction and General (I&G) budget in 2008-2009 is roughly $2.0 M/yr, and ~99.7% of that budget is accounted for by faculty and staff salaries. The balance remaining in the department I&G budget is approximately $50,000/yr, whereas projected actual operating expenses are roughly $100,000. The department depends on overhead return from contracts and grants, some faculty release time, vacant salary lines, and strategically-planned sabbaticals to make up the difference in operation expenses. This has historically allowed the department to stay financially sound. However the overall financial climate of the state, reduced overhead returns, and the shift of

research contracts from departmental accounts to center accounts will make it much more challenging to operate the department in the future.

We expect to see a reduction of 1-2% in the overall UNM budget next year, but the impact of this on the department I&G budget is yet to be determined. These could be permanent reductions. Depending on the size of the department I&G budget reduction, the impact of could range from a very strapped operating budget to the loss of a lecturer, staff or faculty position. These financial challenges are aggravated further by the recent developments with respect to returned overhead (indirect costs associated with grants and contracts). The department has historically relied on returned overhead to support startup expenses of new faculty, and supplement operation expenses of the department.

Currently, the University returns 35% of overhead generated by grants and contracts to the School of Engineering, and a net of 20% of the total overhead generated is returned to the departments. These percentages represent significant reductions in the percentages distributed in the past by the Office of the Vice President of Research. The reduction in distributed percentage, coupled with the shift of research contracts from department accounts to centers, has led to a dramatic reduction in overhead return to the department (Table 10). The shift of research contracts toward centers has been underway for some years, but the recent reduction in overhead return has compounded the situation for the department. At the level of returned overhead projected for the current fiscal year, there will inevitably be a negative impact on operations of the department going forward.

Table 10. Five-year profile of Overhead (indirect cost) returned to the Department of Chemical and Nuclear Engineering (CY = calendar year; FY = fiscal year)

Basis Year	CY2003	CY2004	CY2005	CY2006	CY2007
Distribution Year	FY 2004-05	FY 2005-06	FY 2006-07	FY 2007-08	FY 2008-09
Amount Distributed to Department	$157,802	$209,612	$135,224	$90,078	$37,631*

*projected

The department has traditionally returned as much as 30% of the department allocation to the PI's for professional development and other expenses, retaining the rest to cover departmental operating expenses. Unfortunately, in addition to the reduced overhead percentage returns for the OVPR, the department has seen an increasingly large fraction of the grant production of it's faculty administered through affiliated centers, and there is currently no formal mechanism or agreement for the sharing of overhead return to the centers. Thus the department's total actual overhead returns have plummeted in the last several years. Under these conditions, we are striving to maintain ~10% of the departmental overhead back to PI.'s.

A student course fee of $10/credit hour was implemented in 1999 to provide funds for the replacement, modernization, maintenance and support of laboratory and instructional equipment.

The student course fees provide about $12,000 per semester for lab and instructional enhancement. Recent expenditures from student course fees have included updates to the department computer pod, software licenses, supplies for the printers in the computer pod, etc.

8. Program Comparisons

The 2007-2008 total research expenditures of $6.06 M equates to an average of ~$336 K/faculty member based on 18 faculty. This compares well with statistics reported by many of the ranked colleges of engineering in the U.S. News and World Report, but such department-level statistics are not available. It should also be noted that we currently have 5 new assistant professors whose contributions to research funding and expenditure are also just starting to grow.

Chemical Engineering

At the undergraduate and graduate level, the chemical engineering program curricula are very similar to those of other universities, with a similar foundation of fundamental science and math, similar core courses, etc. Quantitative data for meaningful comparisons to other programs are difficult to come by, and even more difficult to interpret in a meaningful manner. For graduate programs, the rankings produced by *U.S. News and World Report* are commonly referenced for graduate programs, but there is little program specific data available (school/college statistics are available). For chemical engineering graduate programs, the American Chemical Society Directory of Graduate Research has compiled useful data on graduate programs for many years. Below is a table that summarizes some data from the *ACS Directory of Graduate Research* for several departments that could be viewed as peers or departments towards which our department could reasonably aspire to. Though UNM chemical engineering is not currently ranked as a top 50 graduate program, productivity in terms of M.S. and Ph.D. degrees produced compare very favorably with Arizona State University over the 2004-2006 period. Departmental data show an average of 4.5 Ph.D's granted per year over the 2003 – 2008 period. It is apparent that, on a per faculty member basis, our graduate program lags most programs in the top 35 in the number of PhD's produced, but it is approaching the productivity of some (for example, Iowa State University).

Table 11. Chemical engineering program comparison data taken from *2007 ACS Directory of Graduate Research*.

	No. of Faculty	Grad Enrollment 9/06	2004-2006 Avg. M.S. Graduated/yr	2004-2006 Avg. Ph.D. Graduated/yr	U.S. News Ranking
Univ of Colorado	19	92	0.5	15	19
Univ of Washington	18	58	9.5	9.5	24
Iowa State Univ	19	55	1.5	9	33
Arizona State Univ	12	39	7.5	1	46
Univ of Arizona	15	58	18	8	48
UNM ChE	**11**	**48**	**8**	**3**	

Nuclear Engineering

At the undergraduate and graduate level, the nuclear engineering program curricula are very similar to those of other universities, with a similar foundation of fundamental science and math, similar core courses, etc. Quantitative data for meaningful comparisons to other programs are difficult to come by, and even more difficult to interpret in a meaningful manner. Some summary statistics have been compiled periodically by the American Nuclear Society Education and Training Division in the *Nuclear Engineering Education Sourcebook*. Below is a table that

summarizes some data from the *2006-2007 Nuclear Engineering Education Sourcebook* for several departments that could be viewed as peers or departments towards which our department could aspire to.

The UNM nuclear engineering is a small program in terms of number of faculty, but has graduate enrollments and degree productivity that are comparable to several highly ranked programs (as ranked by *U.S. News and World Report*). The highest ranked NE programs clearly have higher annual Ph.D. production than our program over the 2003 – 2006 period; however comparisons to Oregon State University, Georgia Tech, and the University of Tennessee all look fairly strong, especially if the number of faculty are accounted for. It should also be noted that the nuclear engineering faculty only recently became fully staffed with the addition of two new faculty, Cassiano de Oliveira and Adam Hecht. Enrollments at both undergraduate and graduate levels have increased over the last couple of years, (Fall 2008 NE Graduate enrollment was 50). Moreover, we are taking advantage of Federal opportunities to develop scholarship and fellowship programs which offer in-house research opportunities for students. We expect to see both research funding and degree production increase over the next five years.

Table 12. Nuclear engineering program comparison data based on *2006-2007 Nuclear Engineering Education Sourcebook*.

	No. Faculty	Grad Enrollment (06-07)	2003-2006 Avg. No. BS Graduated/yr	2003-2006 Avg. No. M.S. Graduated/yr	2003-2006 Avg. No. PhD Graduated/yr	US News Ranking
Texas A&M	15	96	32.7	10.3	5.3	4
Penn State	12	47	24.0	9.0	3.0	5
UC Berkeley	9	57	7.7	8.3	5.3	6
Oregon State Univ	9	36	17.3	7.0	1.0	8
Georgia Inst Technol	9	74	13.3	7.7	1.3	9
Univ of Tennessee	7	46	16.3	11.7	2.0	11
Univ of New Mexico	**6**	**42**	**9.3**	**6.0**	**1.3**	

9. Future Direction

Strengths (Both Programs)

The department is providing competitive undergraduate and graduate programs that leave our graduates well-prepared for careers in engineering practice, graduate study or professional schools. In the development of its academic programs, the department has been responsive to the interests of students and marketability of it graduates. This is evident, for example, in curriculum changes and customized concentrations in the chemical engineering program, and the development of a Medical Physics program in the nuclear engineering program. Undergraduate and graduate students participate in vigorous research programs. The department views undergraduate research experience as a very valuable complementary educational experience for our students, and a strength of the department. Research is the core of healthy graduate programs, and the department has developed strong, and often multidisciplinary, research programs in a variety of high-impact contemporary research areas. This has been facilitated to a large degree by strategic cultivation of research centers by leaders among the department faculty.

In the chemical engineering program, recent hires constitute a strategic investment into biomedical engineering as a growth area for future research. The establishment of the Center for Emerging Energy Technologies (CEET) represents a commitment to establishment of energy technologies as a complement to the chemical engineering program's traditional research strengths in materials synthesis and characterization, catalysis, and electrochemical technology. Similarly, new hires in the nuclear engineering program and the establishment of the Medical Physics M.S. program and the Center for Nuclear Nonproliferation Science and Technology (CN^2ST) outline new strategic growth directions for the nuclear engineering research profile, complementing the existing research strengths. Though there are currently no strategic future hiring plans in place for the department, this will be part of the faculty discussions that lead up to the Advisory Council meeting in Fall 2009.

The Centers and Institutes affiliated with the department have effectively provided structure and strategic focus to the research activities of the faculty, with real benefits in research productivity, and opportunities for collaboration and pursuit of multi-investigator grant opportunities. The cultivation of Centers has reaped considerable benefits to the department and the School of Engineering. The department views the scientific and academic diversity expressed by our academic and research activities as a core strength.

Challenges: Department

In spite of the many benefits that Centers and Institutes bring to the department, they also bring challenges to operation of the department. These challenges include the financial impact of diversion of research-derived overhead return, which has traditionally been important to operation of the department and faculty startup funds. The current economic times are difficult in general, and these factors compound the broader budget challenges. In addition, the productivity of many of the department's faculty is not directly reflected in department statistics. Administration has generally acknowledged this, and allowed the department to include the Center-related activity of its faculty in reporting. This is critical for continued fair assessment of the department productivity. Similar issues are associated with the development of new graduate programs based largely on the faculty of the department. This includes the Nanoscience and Microsystems (NSMS) graduate program, the medical Physics M.S. program, and the proposed

Biomedical Engineering graduate programs. It is a challenge to promote the success of these programs without compromising our core chemical engineering and nuclear engineering programs, over-burdening the faculty, or impacting the perception within the university of the department productivity, which is commonly based on student credit hour generation and degree production.

There are also special challenges to fair administration of the two nearly independent core academic programs. Examples of the challenges that routinely come up include fair allocation of resources, faculty and staff hires, awards, and graduate seminars. In addition, the department must equitably support parallel graduate student recruiting efforts, and undergraduate student activities and organizations. These challenges and issues typically have financial aspects, but, more importantly, they can affect morale and the spirit of the department in a broad way.

The nuclear engineering and chemical engineering programs are both growing in enrollments. With the addition of new faculty in both programs, and the cultivation of new strategic research growth areas, both programs are healthy and have the potential for continued growth and increased national stature. With respect to the graduate program in particular, the department is concerned that the external perception of our programs does not reflect the inherent quality and productivity. This, of course, impacts program rankings and graduate student recruiting, issues of concern to both programs.

Overall, the trajectory of the department on both academic and research fronts is positive. However, the department and the individual programs do face challenges to stay on this positive trajectory. Some challenges and goals that pertain to both programs in the department include:

- Maintain healthy and historically high undergrad class levels.
- Complete strong positive ABET accreditation reviews in 2010.
- Graduate recruiting and admissions: Both programs have lost some ground in recent years in national and international-level graduate student recruitment. Some changes have been implemented to improve this, but more attention and resources must be focused on this challenge if the faculty, especially junior faculty, are to compete and achieve the scientific prominence that they are capable of.
- Communication and joint strategic developments between the department and affiliated centers that facilitate the success of each, and the associated faculty.
- Creatively address the financial challenges on the horizon, without compromising programs.
- Current budget and hiring constraints leave the department concerned about the ability to add new faculty, or even fill current or future open slots. This would severely limit our ability to continue growth of the research programs, and sustain growth in academic enrollments.

Challenges: Chemical Engineering

Some specific challenges and goals for the chemical engineering programs include:

- Continue to update and modernize undergraduate laboratory experiments.
- Raise the visibility and awareness of the program strengths and faculty achievement. Based on the research and graduate degree productivity of the faculty, the program is capable of recognition as a top-50 program, and should strive for recognition as a top-35 program.

Challenges: Nuclear Engineering

Some specific challenges and goals for the nuclear engineering programs include:

- The program is comparable in several metrics (students, faculty, research, funding, visibility of individual faculty) to other NE programs, some of which are ranked in the top 10 of the US News and World ranking of NE departments. The NE faculty would like to see improved recognition and competitive rankings for their programs.
- Federal investment and support of nuclear energy is growing and several DOE, NRC and NNSA funded programs have been created to strengthen and expand academic nuclear engineering disciplines across the country. The faculty intend to try to be responsive to these opportunities, but there is concern that the small size of the faculty and current restrictions for new hiring will prevent them from taking full advantage of the available opportunities.
- NE undergraduate enrollment has increased to historic highs for our program, while the addition of a Medical Physics graduate concentration has provided a steady stream of M.S. students, but resources to support the increased instructional pressure have not kept pace.

Specific Questions for Evaluators: Both Programs

1. How do the undergraduate and graduate programs for chemical engineering and nuclear engineering compare with other well-respected programs across the country?
2. Are the undergraduate laboratory facilities and experiments adequate and competitive with other strong programs? Do you have suggestions for improvements in this regard?
3. What strategies might help us to improve the success of our graduate student recruiting?
4. Do we have enough faculty to compete effectively for funding opportunities in the various research focus areas that we have targeted? If adding faculty were possible, what research areas would you recommend strengthening?
5. What are best or suggested practices for effective coordination of departmental administration and the administration of affiliated centers in order to maximize the positive impacts of these centers? Specific issues that are of interest include financial coordination and cooperation, balancing of faculty workload expectations and duties, and reporting/credit for productivity.
6. What are suggested practices for effective administration and coordination of interdisciplinary degree programs that are largely supported or led by department faculty? Specific issues that are of interest include impact on enrollments in department programs, student credit hour generation, and faculty workload credit.
7. Do you see opportunities that either of the programs in the department is not recognizing or capitalizing on?

APPENDICES

Appendix A: Chemical Engineering B.S. Curricula and Concentrations

Appendix B: Nuclear Engineering B.S. Curriculum

Appendix C: Alumni Survey

Appendix D: Faculty C.V's

Appendix A: Chemical Engineering B.S. Curriculum and Concentrations

UNIVERSITY OF NEW MEXICO--SCHOOL OF ENGINEERING

CURRICULUM FOR BACHELOR OF SCIENCE DEGREE IN CHEMICAL ENGINEERING-EFFECTIVE FALL 2008

Hours required for graduation: 132[1,2]

Freshman Year

Fall Semester	Cr	Contact Hrs. Lect-Lab	**Spring Semester**	Cr	Contact Hrs Lect-Lab
ChNE 101 Intr Che & Nuclr Engr	1	(1-0)	CS 151L Comp Prog Fund	3	(3-1)
Math 162 Calculus I	4	(4-0)	Math 163 Calculus II	4	(4-0)
Chem 121 Gen Chemistry	3	(3-0)	Chem 122 Gen Chemistry	3	(3-3)
Chem 123L Gen Chem Lab	1	(0-3)	Chem 124L Gen Chem Lab	1	(0-3)
Engl 101 Comp I: Exposition	3	(3-0)	Engl 102 Comp II: Analys & Arg	3	(3-0)
Core Humanities Elective[3]	3	(3-0)	Phys 160 Gen Physics	3	(3-0)
	15	(14-3)		17	(16-4)

Sophomore Year

ChNE 251 Chem Proc Calc I	3	(3-0)	ChNE 253 Chem Proc Calc II	3	(3-0)
Math 264 Calculus III	4	(4-0)	ChNE 302 ChE Thermodynamics	4	(4-0)
Chem 301 Organic Chem	3	(3-0)	Math 316 App Ord Diff Eq	3	(3-0)
Chem 303L Organic Chem Lab	1	(0-3)	Basic Sci Concentration[5]	3	(3-0)
Phys 161 Gen Physics	3	(3-0)	Adv Chem Concentration[6]	3	(3-0)
Econ 105 Intro to Macroeconomics[4]	3	(3-0)			
	17	(16-3)		16	(16-0)

Junior Year

ChNE 311 Intro Transpt	4	(4-0)	ChNE 312 Unit Operations	3	(3-0)
ChNE 317 Chem Engr Analysis	3	(3-0)	ChNE 321 Mass Transfer	3	(3-0)
Engl 219 Tech Writing[4]	3	(3-0)	Basic Engr Elective[7]	3	(3-0)
ChNE 318L Chem Engr Lab I	1	(0-3)	ChNE 319L Chem Engr Lab II	1	(0-3)
Adv Chem Concentration[6]	3	(3-0)	Adv Chem Concentration[6]	3	(3-0)
ChNE 361 Biomolecular Engr	3	(3-0)	ChNE 371 Intro Materials Engr	3	(3-0)
	17	(16-3)		16	(15-3)

Senior Year[9]

ChNE 418L Chem Engr Lab III	1	(0-3)	ChNE 419L Chem Engr Lab IV	2	(0-5)
ChNE 451 Senior Seminar	1	(1-0)	ChNE 454 Proc Dynamics & Control	3	(3-0)
ChNE 461 Chem Reactor Engr	3	(3-0)	ChNE 494L Adv ChE Design	3	(2-3)
ChNE 493L Chem Engr Design	3	(2-3)	Technical Elective[8]	3	(3-0)
Technical Elective[8]	3	(3-0)	Core Fine Art Elective[3]	3	(3-0)
Core Humanities Elective[3]	3	(3-0)	Core Second Language Elective[3]	3	(3-0)
Core Social/Behavior Science Elec[3]	3	(3-0)			
	17	(15-6)		17	(14-8)

1. Only courses with grades of C- or better may be applied toward the bachelor of science degree in chemical engineering.
2. Students must file an application for the B.S. degree prior to the completion of 95 semester hours of applicable courses.
3. Students should consult with advisors to obtain a list of acceptable core humanities, social/behavioral science, fine arts and second language electives. These courses may be taken whenever convenient. Grade must be C- or better.
4. Econ 105 and Engl 219 may be taken in either the sophomore or junior year.
5. Physics 262 or Biology 201L, depending on the student's area of concentration.
6. A minimum of 9 credit hours of advanced chemistry, selected from among CHEM 302, 311, 312, 421, 431 or BIOC 423, depending upon the student's area of concentration. One semester of Physical Chemistry is required for all concentrations. Up to four hours of other natural science courses may be substituted for advanced chemistry. Such advanced natural science courses must build on basic science prerequisites and may include physics, life sciences, and material science. The courses chosen must represent a logical sequence of courses for the concentration and must be approved by the academic advisor.
7. Recommended course ChNE 213. Alternatives are CE 202 or ECE 203. Students in the semiconductor processing concentration may wish to take ECE 203.

8. Technical electives are chosen from approved upper division courses in engineering, mathematics and science. The department requires that these courses be part of an approved concentration. The chairperson may allow up to 6 hours of technical electives for students taking required ROTC courses in aerospace or naval science.
9. Students are encouraged to take the Fundamentals of Engineering (FE) Examination during their senior year. This is the first formal step toward professional registration.

Persons having special needs and requiring auxiliary aid or service should contact the Department of Chemical and Nuclear Engineering (ADA and Rehabilitation Act of 1973)
October 2006

CONCENTRATIONS-CHEMICAL ENGINEERING

Future chemical engineers will conceive and solve problems on a range of scales (nano, micro and macro). They will bring new tools and insights from research and practice in other disciplines: molecular biology, chemistry, solid-state physics, materials science, and electrical engineering. They will also make increasing use of computers, artificial intelligence and expert systems in problem solving, in product and process design, and in manufacturing. Chemical engineering can be viewed as the engineering discipline with the strongest tie to the molecular sciences and therefore is an integral part of multidisciplinary research efforts. To allow students an opportunity to gain in-depth knowledge in specialized areas and to prepare them for diverse career opportunities, we provide five concentrations:

1. Chemical Process Engineering
2. Bioengineering
3. Materials Processing
4. Semiconductor Manufacturing
5. Environmental Engineering

Students choose a basic engineering elective, a basic science elective, 3 advanced chemistry courses and two technical electives. In addition to these courses, the projects in the last design course (494L) and the last laboratory course (419L) provide opportunities to gain experience in the chosen concentration.

BASIC ENGINEERING ELECTIVE

The recommended course is ChNE 213. Alternatives are CE 202 or ECE 203. Students in the semiconductor processing concentration may wish to take ECE 203.

BASIC SCIENCE ELECTIVE

Students in Bioengineering or Environmental Engineering concentrations will take Biology 201L, all others take Physics 262 during the second semester of the sophomore year.

ADVANCED CHEMISTRY AND SCIENCE ELECTIVES

A minimum of 9 credit hours of advanced chemistry, selected from among CHEM 302, 304L, 311, 312, 421, 431 or Biochemistry 423, depending upon the student's area of concentration. One year of Physical Chemistry is required for all concentrations. Up to four hours of other natural science courses may be substituted for advanced chemistry. Such advanced natural science courses must build on basic science prerequisites and may include physics, life sciences, and material science. The courses chosen must represent a logical sequence of courses for the concentration and must be approved by the academic advisor.

TECHNICAL ELECTIVES

Students have the opportunity to take 6 credit hours of technical electives. Three hours must be engineering courses within the department or the school. The other three hours may be taken outside of the school but must be a logical part of the concentration.

CHEMICAL PROCESS ENGINEERING CONCENTRATION

The Chemical Process Engineering concentration is designed to provide maximum flexibility for students to pursue career opportunities in a wide range of industries as a process engineer. Historically, many chemical process engineers have found employment in the petroleum or chemical industries, and many still do. However, chemical engineers with a strong process engineering foundation are in increasing demand in many other technology areas, including pharmaceuticals, semiconductors and electronic materials, and environmental or "green" engineering. This concentration builds on the traditional process engineering emphasis, allowing the technical electives to be chosen by the student in consultation with his adviser to fit the interests or professional goals of the student.

Basic Science Elective		
Phys 262	General Physics	3
Advanced Chemistry and Science Electives		
Chem 302	Organic II	3
Chem 311	Physical Chemistry I	3
Chem 312	Physics Chemistry II	3
Technical Electives		
Technical Elective		3
Technical Elective (Engr)		3

BIOENGINEERING CONCENTRATION

Since biological and medical systems involve complex chemical and physical processes, chemical engineering is a natural professional background for bioengineering applications. Bioengineering is an interdisciplinary field that combines the tools and methods of engineering to address challenges in the health sciences and in basic research. Bioengineers strive to understand biological systems, from molecules to whole organisms, from a quantitative and analytical perspective. Because of this in-depth study, bioengineers are uniquely qualified to work at the interface between living and non-living systems, enhancing our ability to measure, image, repair, or replace physiological substances or processes. Training in bioengineering prepares students for graduate school or industry, and is an excellent preparation for professional programs (medicine, dentistry, nursing, pharmacy). Career opportunities for bioengineers at the B.S. level include the biosensor, pharmaceutical and medical device industries as well as positions in hospitals, federal labs, and environmental agencies.

Basic Science Elective

Biol 201	Cell Biology	4

Advanced Chemistry and Science Electives

Chem 302	Organic II	3
Chem 312	Physical Chemistry	3
Advanced Biology*		3

Technical Electives

Technical Elective	3
Technical Elective (Engr)	3

*Typical choices for the advanced biology course would be BIOL 202, 237, 238, 239L, BIOC 423 or CHEM 421.

MATERIALS PROCESSING CONCENTRATION

The Materials Processing concentration is designed to add additional emphasis in inorganic, polymeric or biological materials, depending on the student's interest. Students who are interested in working in the realm of high technology materials, biomedical materials, or nanotechnology should choose this concentration. These rapidly developing fields are expected to provide many job opportunities in the next decade. New materials are currently being developed whose properties depend strongly on their micro/nanostructure and processing history. Materials included in this category are advanced ceramics, polymers, composites, photonics, superconductors, semiconductors, and recording media. This concentration provids flexibility for students interested in inorganic or organic materials technology.

Basic Science Elective

Phys 262	General Physics or	
BIOL 201	Cell Biology	3

Advanced Chemistry and Science Electives

Chem 311	Physical Chemistry I	3
Chem 312	Physical Chemistry II	3
Chem 431	Adv Inorganic Chem or	
ChNE 475	Polymer Sci and Eng	3

Technical Electives

Technical Elective	3
Technical Elective (Engr)	3

SEMICONDUCTOR MANUFACTURING CONCENTRATION

There is an increasing demand for chemical engineers in high technology oriented semiconductor manufacturing companies like Intel, Motorola, IBM, etc. This concentration is designed to prepare the student in the fundamental unit operations used in semiconductor manufacturing (oxidation, diffusion, lithography, plasma etch, CVD, ion implant and metalization) and statistical methods used extensively in the industry to optimize the performance of these unit operations. The continuing revolution occurring in

computer technology virtually insures there will be a strong future demand for engineers with the background needed for semiconductor manufacturing. The goal of this concentration is to introduce students to the specific chemical engineering tools used in micro-chip fabrication.

Basic Science Elective

Phys 262	General Physics	3

Advanced Chemistry and Science Electives

Chem 311	Physical Chemistry I	3
Chem 312	Physical Chemistry II	3
Chem 431	Adv Inorganic Chem	3

Technical Electives

ECE 371L	Materials and Devices	4
Technical Elective		3

ENVIRONMENTAL ENGINEERING CONCENTRATION

The chemical engineer with a concentration in waste management will be prepared to enter a field of growing importance. This field deals with treatment of waste to reduce its volume, to recover recyclable resources and to prepare appropriately for long-term disposal. Interesting applications exist in atmospheric discharge control and clean-up, bio-treatable water decontamination, soil remediation, and nuclear byproduct handling. Increasingly, chemical engineers will be required to develop new processes to minimize byproduct and waste generation, and achieve higher energy efficiencies.

Basic Science Elective

Bio 201	Cell Biology	4

Advanced Chemistry and Science Electives

Chem 302	Organic II	3
Chem 312	Physical Chemistry	3
Biochem 423	Intro to Biochem or advanced biology*	3

Technical Electives

Technical Elective		3
Technical Elective (Engr)		3

*Typical choices for the advanced biology course would be BIOL 202, 237, 238, 239L, or CHEM 421.

Appendix B: Nuclear Engineering Curriculum

UNIVERSITY OF NEW MEXICO
SCHOOL OF ENGINEERING
CURRICULUM FOR BACHELOR OF SCIENCE DEGREE IN NUCLEAR ENGINEERING

Hours[6] Required for Graduation: 133

Fall Semester		**Spring Semester**	
Course Title	Cr. Hrs.	Course Title	Cr. Hrs.
		FRESHMAN YEAR	
Chem 121L General Chem/Lab	4	Chem 122L General Chem/Lab	4
Math 162L Calculus I	4	Math 163L Calculus II	4
Engl 101 Comp I: Exposition	3	Engl 102 Comp II: Analys&Arg	3
Ch-NE 101 Intro to ChE/NE	1	Physcs 160 General Physics	3
Core Humanities Elective[1]	3	CS 151 Comp Prog Fund	3
	15		17
		SOPHOMORE YEAR	
Ch-NE 230 Princ Radiation Prot	3	Ch-NE 231 Prin of Nucl Engr	3
Math 264L Calculus III	4	Math 316 Appl Ord Diff Equas	3
CE 202 Engineering Statics	3	**ChNE 240 Circuits for ChNEs**	3
Physcs 161 General Physics	3	Physcs 262 General Physics	3
Econ 105 Intro Macroeconomics	3	Engl 219 Technical Writing	3
Ch-NE 213 – Engr Skills	2	**Ch-NE 364 Nuclear Systems**	2
	18		17
		JUNIOR YEAR	
Ch-NE 311 Intro Transport Phenma	4	Ch-NE 312 Unit Operations	**3**
Ch-NE 317 Chem Nucl Engr Analy	3	Ch-NE 313L Intro Lab Technque	3
Ch-NE 323L Nucl Det Meas/Lab	3	**Ch-NE 310 Neutron Diffusion**	3
Ch-NE 371 Nucl. Engr. Material Sci	2	Ch-NE 330 Nucl Engr Science	2
Ch-NE 372 Nucl Reactor Engr	2	**Technical Elective[2]**	3
Core Soc. & Behav. Sci. Elective[1]	3	Core Second Lang. Elective[1]	3
	17		17
		SENIOR YEAR[3,4]	
Ch-NE 410 Nucl. Reactor Thry I	3	Ch-NE 413L Nucl Engr Lab I	3
Ch-NE 464 Thrml-Hydrl Nucl Sys	3	Ch-NE 452 Senior Seminar	1
Ch-NE 497L **NE Comp Appl**	3	Ch-NE 498L Nuclear Engr Design	4
Ch-NE 462? Monte Carlo Tech	3	Nuclear Engr. Tech. Elective[5]	3
Core Humanities Elective[1]	3	Core Fine Arts Elective[1]	3
Technical Elective[2]	3		14
	18		

1 Students should consult the UNM catalog, p.40 or an advisor to obtain a list of acceptable courses to fulfill the core curriculum requirements. These courses may be taken whenever convenient.

2 Technical electives are chosen from approved upper division courses in engineering, mathematics and science. The chairperson may allow up to 6 hours of technical electives for students taking required ROTC course in aerospace or naval science.

3 Students must file an application for the B.S. Degree prior to the completion of 95 semester hours of applicable courses.

4 Students are encouraged to take the Fundamentals of Engineering (FE) Examination during their senior year. This is the first formal step toward professional registration.

5 The NE Technical Elective is chosen from a list of approved upper division nuclear engineering courses with the approval of the student's advisor.

6 To count towards graduation credit hours, each course must be completed with a grade of C- or better. Courses used to fulfill the UNM core curriculum require a grade of C or better.

SURVEY INSTRUMENTS ALUMNI SURVEY

Appendix C: Alumni Survey

Chemical and Nuclear Engineering

Alumni Survey

Purpose: The response to this survey will help us assess the effectiveness and quality of our undergraduate program. To this end, we ask you to answer the questions as honestly as possible, and to make any comments that you feel are important to efforts to evaluate and improve our undergraduate program. Thank you in advance for participating in the survey.

Confidentiality: The information that your provide us will be treated confidentially. Your name (if provided) will be removed from the survey form before the results are compiled for presentation to the faculty.

Survey Return Information: You may enter responses on the electronic document and return as an electronic attachment to Susan Pinter at pinter@unm.edu, or print the form and send to:
Susan Pinter
Department of Chemical and Nuclear Engineering
MSC 01-1120
1 University of New Mexico
Albuquerque, NM 87131

The personal information given will be separated from the rest of the survey results before being given the faculty.

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1. Personal Information
Name:
Email Address:
Contact Address:

Professional Experience: Please briefly outline your professional experiences since graduating from the chemical engineering program at UNM. Please include names of companies that you have worked for, the positions you have held, your principal duties, the names of any graduate or professional schools that you have attended, any degrees earned, and any other continuing education or professional development courses that you have participated in.

For each of the statements below, please rank from one to five (one being "strongly disagree", five being "strongly agree") how well your undergraduate chemical engineering education at UNM prepared you for success in your professional career, including preparation for graduate or professional school if you have continued your education. Please add any specific comments that you feel are important.

1. The technical knowledge and skills that I gained prepared me for success in my career and/or post-graduate education.

(strongly disagree) 1 2 3 4 5 (strongly agree) Not applicable

Comments: Spring 2008 Results (9 respondents):
SA(5): 6 MA(4): 1 N(3): 1 MD(2): 1 SD(1): 0

2. The mathematical and computer skills that I gained prepared me for success in my career and/or post-graduate education.

(strongly disagree) 1 2 3 4 5 (strongly agree) Not applicable

Comments: Spring 2008 Results (9 respondents):
SA(5): 5 MA(4): 1 N(3): 3 MD(2): 0 SD(1): 0

3. My design and problem-solving experience prepared me for success in my career and/or post-graduate education.

(strongly disagree) 1 2 3 4 5 (strongly agree) Not applicable

Comments: Spring 2008 Results (9 respondents):
SA(5): 6 MA(4): 2 N(3): 0 MD(2): 0 SD(1): 1

4. The communication skills that I developed prepared me for success in my career and/or post-graduate education.

(strongly disagree) 1 2 3 4 5 (strongly agree) Not applicable

Comments: Spring 2008 Results (9 respondents):
SA(5): 4 MA(4): 2 N(3): 2 MD(2): 0 SD(1): 1

5. My education prepared me to function effectively as a member of a multidisciplinary team.

(strongly disagree) 1 2 3 4 5 (strongly agree) Not applicable

Comments: Spring 2008 Results (9 respondents):
SA(5): 5 MA(4): 1 N(3): 1 MD(2): 1 SD(1): 1

6. My education prepared me to recognize and account for the social, ethical and environmental impacts of my scientific and engineering activities.

(strongly disagree) 1 2 3 4 5 (strongly agree) Not applicable

Comments: Spring 2008 Results (9 respondents):
SA(5): 3 MA(4): 5 N(3): 0 MD(2): 0 SD(1): 1

7. My education made me aware of the need for lifeling learning in my career, and the various ways in which this can be pursued .

(strongly disagree) 1 2 3 4 5 (strongly agree) Not applicable

Comments: Spring 2008 Results (9 respondents):
SA(5): 5 MA(4): 2 N(3): 1 MD(2): 1 SD(1): 0

Appendix D: Short C.V.'s of Regular Faculty and Lecturers

Plamen B. Atanassov, PhD. Associate Professor

Department of Chemical and Nuclear Engineering,
Director of Center for Emerging Energy Technologies, School of Engineering, University of New Mexico,
209 Farris Engineering Center, Albuquerque, NM 87131
E-mail plamen@unm.edu Tel: (505) 277 2640 Fax: (505) 277 5433 Web site: http://unm.edu/~elchem/

EDUCATION

1987 University of Sofia, Department of Chemistry, Sofia, Bulgaria, M.S. in Chemical Physics
1988 Frumkin's Institute of Electrochemistry, Moscow, Russia, Specialization in Bioelectrochemistry
1995 Bulgarian Academy of Sciences, Sofia, Bulgaria, PhD in Chemistry (Electrochemistry)

EMPLOYMENT

August 2000 - present	Chemical & Nuclear Engineering, University of New Mexico, Albuquerque, NM *Assistant Professor and Associate Professor (since July 2006)* *Director of UNM Center for Emerging Energy Technologies (since July 2007)*
1999 – 2000	Superior MicroPowders LLC, Albuquerque, NM *Senior Scientist and Project Manager*
1992 – 1999	Chemical & Nuclear Engineering, University of New Mexico, Albuquerque, NM *Senior Research Associate (92-93) and Research Assistant Professor (93-99)*
1987 – 1992	Central Laboratory of Electrochemical Power Sources, Bulgarian Acad. Sciences *Staff Chemist (87-90), Staff Scientist (90-91) and Research Fellow (91-92)*

MEMBERSHIP: ECS, ACS, AIChE, ASEE

AWARDS:
2000 and 2005 "Top Gobbler" Students' Appreciation Award
2003 UNM School of Engineering Junior Faculty Excellence in Research Award
2004 UNM School of Engineering Junior Faculty Excellence in Teaching Award
2004 2005 and 2006 UNM/STC Inventors Award
2005 NM Economic Development Department, "Technology All-Starr" Award
2007 ACS Division of Fuel Chemistry Outstanding Service Award
2008 UNM School of Engineering Senior Faculty Excellence in Research Award
2008 UNM University Libraries Faculty Acknowledgement Award

PUBLICATIONS: co-author in 106 journal publications, including 9 review articles and 30 US Patents:
Five Recent Relevant Journal Publications (XPS and Biofuel and Fuel Cell Technology):

- D. Ivnitski, K. Artyushkova and **P. Atanassov**, Electrochemical Studies of Redox Copper Centers of Bilirubin Oxidase from the Fungi *Myrothecium verrucaria* based on Direct Bioelectroanalysis, *Bioelectrochemistry*, 74 (2008) 101-110
- J. Ziegelbauer, T. Olson, F. Alamgir, C. Jaye, **P. Atanassov**, S. Mukerjee, Direct Spectroscopic Observation of the Structural Origin of Peroxide Generation from Co-Based Pyrolyzed Porphyrins for ORR Applications, *J. Phys. Chem. C.*, 112 (2008) 8839–8849
- K. Artyushkova, S. Pylypenko, T.S. Olson, J.E. Fulghum and **P. Atanassov**, Predictive Modeling of Electrocatalyst Structure Based on Structure-to-Property Correlations of X-ray Photoelectron Spectroscopic and Electrochemical Measurements, *Langmuir*, 24 (2008) 9082-9088
- S. Pylypenko, S. Mukherjee, T. Olson and **P. Atanassov**, Non-Platinum Electrocatalysts Based on Pyrolyzed Transition Metal Macrocycles, *Electrochimica Acta*, 53 (2008) 7875-7883
- K. Artyushkova, S. Levendosky, **P. Atanassov** and J. Fulghum, XPS Structural Studies of Nano-Composite Non-Platinum Electrocatalysts for Polymer Electrolyte Fuel Cells, *Topics in Catalysis*, 46 (2007) 263-275, Invited Article

Five Additional Relevant Journal Publications (Major Reviews):

- S. Calabrese Barton, J. Gallaway and **P. Atanassov**, Bio-Fuel Cells for Implantable and Micro-Scale Devices (Review), *Chemical Reviews*, 104 (2004) 4867-4886, Invited Review
- D. Ivnitski, I. Abdel-Hamid, **P. Atanasov**, E. Wilkins and S. Stricker, Application of Electrochemical Biosensors for Detection of Food Pathogenic Bacteria, (Review), *Electroanalysis*, 12 (2000) 317-325
- D. Ivnitski, I. Abdel-Hamid, **P. Atanasov**, and E. Wilkins, Biosensors for Detection of Pathogenic Bacteria (Review), *Biosensors & Bioelectronics*, 14 (1999) 599-624
- A.L. Ghindilis, **P. Atanasov**, M. Wilkins and E. Wilkins, Immunosensors: Electrochemical Sensing and Other Engineering Approaches (Review), *Biosensors & Bioelectronics*, 13 (1998) 113-131
- A.L. Ghindilis, **P. Atanasov** and E. Wilkins, Enzyme Catalyzed Direct Electron Transfer: Fundamentals and Analytical Applications (Review), *Electroanalysis*, 9 (1997) 661-674

Synergistic Activities:

- Participated in building the *Nano-Science and Micro-Systems* (NSMS) program at UNM. Developed graduate courses "Electrochemical Engineering" and "Biosensors: Fundamentals and Applications". Was responsible for the Nano-Bio-Interfaces thrust area. Now focusing on Nano-materials for Energy Applications.
- Founding director of UNM *Center for Emerging Energy Technologies*, a research arm of the School of Engineering that operates DOE, DOD and NSF collaborative programs with emphasis on building energy applications from materials to systems: DOE-EPSCoR *Implementation Award*, AFOSR-MURI on *Biofuel Cells* and NSF I/UCRC *Ceramic and Composite Materials Center*.
- Co-inventor in 16 granted US patents, 11 published US patent applications, 4 filed utility patent applications and 3 provisional applications, as well as 6 Bulgarian Patents. Electrocatalysts inventions are being commercialized as Dynalyst® brand by Cabot Corp.
- Book editor for E. Katz and **P. Atanassov** (Eds.) *Bio-Fuel Cells: Fundamentals, Technology and Applications*. In: *Modern Aspects of Electrochemistry*, expected mid 2009, Springer (NY)
- Regular peer-reviewer *for J. Electrochemical Society*, *Electroanalysis* (Wiley-VCH, New York, NY), *Biosensors & Bioelectronics*, *Sensors & Actuators*, *Analytica Chimica Acta*, *Biotechnology & Bioengineering* (Elsevier, Amsterdam, Netherlands) and book reviewer for the ACS,

Collaborators (within last 48 months):

Gabriel P. Lopez, Abhaya Datye, Tim Ward, Julia Fulghum, Dimiter Petsev, David Whitten, Dmitri Ivnitski, Kateryna Artyushkova, Ravil Sitdikov and Jeff Brinker, *University of New Mexico;* Orlin Velev, *North Carolina State University*, Scott Calabrese Barton, *Michigan State University*, Shelley Minteer, *University of Saint Louis*, Scott Banta, *Columbia University*, Sanjeev Mukerjee, *Northeastern University*, Bor Yann Liaw and Michael Cooney, *University of Hawaii, Manoa*; Don Weinkauf, *New Mexico Tech*, Heinz Nakotte, *New Mexico State University*, Juchao Yan, *Eastern New Mexico University*, Suzan Brozik, Hongyou Fan, Chris Apblett, and Chris Cornelius, *Sandia National Laboratories*, Piotr Zelenay and Rod Borup, *Los Alamos NL*; Heather Luckarift and Glenn Johnson, *AFRL Tyndall AFB*; Berislav Blizanac Gordon Rice and Paolina, Atanassova, *Cabot-SMP, Albuquerque, NM*
Ebtisam Wilkins, *University of New Mexico*, Post-doctoral Advisor; Ilia Iliev, *Central Laboratory of Electrochemical Power Sources, Sofia, Bulgaria*, Dissertation Advisor

Graduate Students:

Former: Rhett Zyla, Sanjoy Mukherjee, Adam Rowen, Stephen Levendosky, Brian Key, Frisia Colon, Zhen Yuan, Dayle Kerr, David Wood; Madhu Dowlapalli, Tim Olson, Elise Switzer, Oana Marina
Current:, Gautam Gupta, Dough Reed, Erika Cooley, Daniel Konopka, Rosalba Rincon, Kyle Fenton, Ron Goeke, Paul Maksymiuk, Shayna Brocato, Yongming Tian, Jared Roy, Bayo Falase, Paul Bisong
Post-Docs - *Former:* Juchao Yan, Vijay Rajendran, Marcos Barella, Claudia Luhrs, Dmitri Brevnov, Ravil Sitdikov; *Current:* Svitlana Pylypenko, Tim Olson, Jhuan Toro and Dmitri Ivnitski (Res. Prof.).

BIOGRAPHICAL SKETCH

Provide the following information for the key personnel and other significant contributors in the order listed on Form Page 2.
Follow this format for each person. **DO NOT EXCEED FOUR PAGES.**

NAME	POSITION TITLE
C. Jeffrey Brinker	Distinguished and Regent's Professor of Chemical and Nuclear Engineering and Molecular Genetics and Microbiology, the University of New Mexico. Fellow; Sandia National Laboratories
eRA COMMONS USER NAME	

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, include postdoctoral training.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	YEAR(s)	FIELD OF STUDY
Rutgers University, New Brunswick, NJ	B.S.	1972	Ceramic Science
Rutgers University, New Brunswick, NJ	M.S.	1975	Ceramic Science
Rutgers University, New Brunswick, NJ	Ph.D	1978	Ceramic Science

A. Positions and Honors.

1979 - 1991 Member of the Technical Staff, Chemistry and Ceramics Department, Sandia National Laboratories (SNL)
1991 - 1999 Distinguished National Laboratory Professor of Chemistry and Chemical and Nuclear Engineering, the University of New Mexico (UNM)
1991 - 1998 Distinguished Member of the Technical Staff, Direct Fabrication Department, SNL
1999 - 2003 Senior Scientist, Chemical Synthesis and Nanomaterials Department, SNL
1999 - 2006 Professor of Chemistry and Chemical & Nuclear Engineering, UNM
2003 - Current Sandia Fellow (one of 2) Center for Self-Assembled Materials, SNL
2006 - 2008 Regent's Professor of Chemical & Nuclear Engineering; Molecular Genetics and Microbiology, UNM
2008 – Current Distinguished Professor of Chemical and Nuclear Engineering and Molecular Genetics and Microbiology, UNM

Honors and Distinctions:

1988 - Zachariasen Award for best contribution to the glass science literature 1985-1987 (awarded by the Journal of Non-Crystalline Solids).
1994, 1992 - Department of Energy Basic Energy Sciences Award for *Significant Implications for DOE Related Technologies in Metallurgy and Ceramics.*
1995, 1986 - Department of Energy Basic Energy Sciences Award for *Sustained Outstanding Research in Metallurgy and Ceramics.*
1996 - R&D100 Award - Low Temperature/Pressure Process to Produce Aerogels
1996 - Lockheed Martin NOVA (New Star) Award
1996 - American Chemical Society Ralph K. Iler Award in the Chemistry of Colloidal Materials.
1998 - Motorola/CMEM Research Mentorship Award
1998 - Department of Energy Basic Energy Sciences Award for *Outstanding Scientific Accomplishment in Metallurgy and Ceramics*
2001 - National Collegiate Inventors Competition Award for *Optically-Adjustable Nanostructures*
2002 - Elected to National Academy of Engineering
2002 - DOE Ernest O. Lawrence Memorial Award in Materials Science
2003 - Materials Research Society MRS Medal
2005 - The University of New Mexico Research Excellence Award
2006 - Rutgers University Distinguished Alumnus Award
2007 - R&D100 Award - Self-Assembly of Nanoparticle Films
2008 - R&D100 Award: Patterned Superhydrophobic Surfaces

2008 - Edward R. Orton Jr. Memorial Award, American Ceramic Society and ASM
2009 - Elected Fellow of the Materials Research Society (MRS)

B. Selected peer-reviewed publications (in chronological order) **(H-Index = 50, ISI Top Twenty Papers, Materials Science Paper of Decade)**

1. Prakash, SS; Brinker, CJ; Hurd, AJ; Rao, SM. Silica aerogel films prepared at ambient pressure by using surface derivatization to induce reversible drying shrinkage.
Nature; 374, p.439; 1995 **(134 citations)**

2. Raman NK, Anderson MT, **Brinker CJ**. Template-based approaches to the preparation of amorphous, nanoporous silicas. Chemistry of Materials. 1996. (8)1682-1701 **(447 citations).**

3. Lu YF, Ganguli R, Drewien CA, Anderson MT, **Brinker CJ**, Gong WL, Guo YX, Soyez H, Dunn B, Huang, MH, Zink JI. Continuous formation of supported cubic and hexagonal mesoporous films by sol-gel dip-coating. NATURE. 1997. (389)364-368 **(755 citations).**

4. Sellinger A, Weiss PM, Nguyen A, Lu YF, Assink RA, Gong WL, **Brinker CJ**. Continuous self-assembly of organic-inorganic nanocomposite coatings that mimic nacre. NATURE. 1998. (394)256-260 **(242 citations).**

5. **Brinker CJ**, Lu YF, Sellinger A, Fan HY. Evaporation-induced self-assembly: Nanostructures made easy. Advanced Materials. 1999. (11)579 **(563 citations).**

6. Lu YF, Fan HY, Stump A, Ward TL, Rieker T, **Brinker CJ**. Aerosol-assisted self-assembly of mesostructured spherical nanoparticles. Nature. 1999;398(6724)223-226 **(349 citations).**

7. Lu YF, Fan HY, Doke N, Loy DA, Assink RA, LaVan DA, **Brinker CJ**. Evaporation-induced self-assembly of hybrid bridged silsesquioxane film and particulate mesophases with integral organic functionality. J American Chemical Society. 2000. 122(22)5258-5261 **(297 citations).**

8. Fan HY, Lu YF, Stump A, Reed ST, Baer T, Schunk R, Perez-Luna V, Lopez GP, **Brinker CJ**. Rapid prototyping of patterned functional nanostructures. Nature 2000 45(6782)56-60 **(207 citations)**.

9. Bhatia, RB; Brinker, CJ; Gupta, AK; Singh, AK. Aqueous sol-gel process for protein encapsulation Chemistry of Materials; 12, p.2434; 2000 **(115 citations)**

10. Doshi DA, Huesing NK, Lu MC, Fan HY, Lu YF, Simmons-Potter K, Potter BG, Hurd AJ, **Brinker CJ**. Optically, defined multifunctional patterning of photosensitive thin-film silica mesophases. Science. 2000;290(5489)107-111 **(93 citations).**

11. LuYF, Yang Y, Sellinger A, Lu MC, Huang JM, Fan HY, Haddad R, Lopez G, Burns AR, Sasaki DY, et.al. Self-assembly of mesoscopically ordered chromatic polydiacetylene/silica nanocomposite. Nature. 2001; 410(6831)913-917 **(206 citations).**

12. Fan, HY; Yang, K; Boye, DM; Sigmon, T; Malloy, KJ; Xu, HF; Lopez, GP; Brinker, CJ
Self-Assembly of Ordered, Robust, Three-Dimensional Gold Nanocrystal/ Silica Arrays
Science; 304, p.567; 2004 **(139 citations)**

13. Baca HK, Ashley C, Carnes E, Lopez D, Flemming J, Dunphy D, Singh S, Chen Z, Liu N, Fan HY, López GP, Brozik SM, Werner-Washburne M, **Brinker CJ**. Cell-directed assembly of lipid-silica nanostructures providing extended cell viability. Science 2006. (313)337-341.

14. Singh S, Houston J, van Swol F, **Brinker CJ**. Drying transition of confined water. NATURE 2006. (442)526.

15. Baca, HK, Carnes, EC, Singh, S, Ashley, CE, Lopez, DM, **Brinker, CJ.** Cell-Directed Assembly of Bio/Nano Interfaces – A New Scheme for Cell Immobilization. Accts Chem. Res 2007. 40(9)836-45.

16. T-H Yang, CK Yee, ML Amweg, S. Singh, EL Kendall, AM Dattelbaum, AP Shreve, **CJ Brinker**, and AN Parikh. Optical detection of ion-channel-induced proton transport in supported phospholipid bilayers. NanoLetters, 2007, v. 7, no. 8, p. 2446-2451

17. Pang, J.; Xiong, S.; Jaeckel, F.; Sun, Z.; Dunphy, D.; **Brinker, C. J**. Free-Standing, Patternable Nanoparticle/Polymer Monolayer Arrays Formed by Evaporation Induced Self-Assembly at a Fluid Interface. Am. Chem. Soc.; (Communication); 2008; March 19, 2008; v. 130 (11) pp. 3284+.

18. Liu, J; Stace-Naughton, A; Jiang, X; **Brinker CJ.** Porous Nanoparticle Supported Lipid Bilayers (Protocells) as Delivery Vehicles. J. Am. Chem. Soc, Comm. Published online Jan. 13, 2009, http://pubs.acs.org.

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Albuquerque, NM 87131-1141 — Email: canavan@unm.edu

EDUCATION

The George Washington University
Doctor of Philosophy: Physical Chemistry — May 2002
Advisor: David E. Ramaker

The George Washington University
Master of Philosophy: Physical Chemistry — January 2000

University of California Santa Barbara
Bachelor of Arts: Biology — December 1996

ACADEMIC APPOINTMENTS

University of New Mexico, Albuquerque NM

Assistant Professor, Department of Chemical and Nuclear Engineering — 2005-present

University of Washington, Seattle WA, Laboratory of Dr. David Castner

Senior Postdoctoral Fellow, Departments of Chemical and Bioengineering — 2002-2005
National ESCA and Surface Analysis Center for Biomedical Problems (NESAC/BIO)

PROFESSIONAL EXPERIENCE

Los Alamos National Laboratory, Los Alamos, NM

Chemist, Chemistry Science and Technology Division — 1994-1997
Oversaw analytical production of a mobile chemical laboratory, responsible for practical implementation of research projects and assisted in production of resultant publications and presentations. Instrumental to the development and validation of analytical systems supporting Rocky Flats Waste Treatment Project.

Los Alamos National Laboratory, Los Alamos, NM

Staff Research Assistant, Chemistry Science and Technology Division — 1991-1994
Responsible for method development and programming of prototype robotics system, development of software programs, implementation and review of commercial software.

COURSES TAUGHT

Undergraduate Thermodynamics (ChNE 302)	Spring 2006-present
Graduate Thermodynamics (ChNE 542)	Fall 2005 - present
Undergraduate Biomolecular Engineering (ChNE 499J/361)	Fall 2006-present
Undergraduate Senior Seminar (ChNE 471)	Fall 2005

AWARDS

Apple Polisher Award, recognition from Chi Omega sorority members for outstanding contribution to higher education	2008
Untenured Faculty Award, 3M Corporation	2006
Dorothy M. and Earl S. Hoffman Scholarship, AVS	1999
Benjamin D. Van Evera Memorial Teaching Prize, George Washington University	1998

FUNDING: CURRENT AWARDS

UNM Research Allocations (RAC) Committee	"Smart" Polymer Microgels for Cancer Cell Receptor Quantification	$4,000 2009-2010 PI
UNM Office of Graduate Studies (OGS) Graduate Research Project and Travel Grant	Single Cell Release from "Smart" Microgels for Cancer Receptor Quantification	$1,000 2009-2010 Mentor
National Science Foundation (NSF)	UNM-Harvard: Partners for Leadership to Enhance Biomaterials	$2,537,000 2006-2011 Co-PI

SERVICE

Director, Biomaterials Engineering Outreach Program	2006-2007
Contributing Faculty Member, Biomaterials Engineering Outreach Program	2006-present
Faculty Advisor, UNM Student Chapter of the Biomedical Engineering Society	2005-present
Member, ChNE Undergraduate Student Curriculum Development Committee	2005-present
Member, ChNE Graduate Student Recruitment Committee	2005-2008
Member, ChNE Graduate Student Qualifications Exam Committee	2008
Member, ChNE Faculty Search Committee	2006-2008
Member-at-large, NM Chapter of the American Vacuum Society (AVS)	2006-2008
Member-at-large, AVS BioInterfaces Division	2006-present
Manuscript Reviewer: *Surface and Interface Analysis, Langmuir, Plasma Processes and Polymers, Biomaterials, Advanced Materials, Biomacromolecules, Journal of the American Ceramic Society*	2005-present
Grant Proposal Reviewer: National Science Foundation, Irish Health Research Board	2005-present

SELECTED PUBLICATIONS (of 12 refereed publications, 5 in preparation, 4 submitted, 1 chapter, 12 non-refereed publications, 14 with undergraduates) †Indicates undergraduate researcher.

Articles in Preparation

1. Cooperstein, M.;† CANAVAN, H.E.; "Applications and Uses of Biological Cell Detachment from pNIPAM," in preparation for submission as a Featured Article in *Langmuir*.
2. Lucero, A.E.; Reed, J.A.; Cooperstein, M.;† CANAVAN, H.E.; "Fabrication and Characterization of Thermoresponsive Films Deposited by an RF Plasma Reactor," in preparation for submission to *Plasma Processes and Polymers*.
3. Reed, J.A.; Lucero, A.E.; Cooperstein, M.;† CANAVAN, H.E.; "The Effects of Cell Culture Parameters on Cell Release Kinetics from pNIPAM," *Journal of Applied Biomaterials & Biomechanics*, **6** (2), 81-88 (2008).
4. CANAVAN, H.E.; Stanton, M.; Lopez, K.; Grubin, C.; Graham, D.J., " 'Finger Kits': An Interactive Demonstration of Biomaterials and Engineering for Elementary School Students," *Chemical Engineering Education*, **42** (3), 125-131 (2008).
5. CANAVAN, H.E.; Cheng, X.; Graham, D.J.; Ratner, B.D.; and Castner, D.G., "Comparison of Native Extracellular Matrix with Adsorbed Protein Films using Mass Spectrometry," cover art of *Langmuir,* **23** (1), 50-56 (2007).

Eric C. Carnes, Ph.D.
University of New Mexico, Department of Chemical and Nuclear Engineering
Farris Engineering Center, Room 203A
Albuquerque, NM 87106
(505) 350-6538
eccarne@unm.edu

EDUCATION

University of New Mexico, Albuquerque, NM
Ph.D. in Chemical Engineering **2008**
Dissertation: "Integration of living cells into nanostructures using self-assembly"
Interdisciplinary research involving nanotechnology, cell biology, and engineering

University of New Mexico, Albuquerque, NM
M.A. in Chemical Engineering **2003**
Thesis: "A new immunosensor for detection of extremely low levels of pathogenic bacteria"

University of New Mexico, Albuquerque, NM
B.S. in Chemical Engineering **2002**
Magna Cum Laude

AWARDS

Interdisciplinary Graduate Research Fellowship/Traineeship (INCBN IGERT) **2006 – 2008**
Ford Foundation Fellowship **2003**

TEACHING EXPERIENCE

University of New Mexico, Albuquerque, NM
Visiting Lecturer – ChNE 251, 312, 318L, 319L, 418L, 419L **2008-**
Developed new laboratory experiments and modernized course structures.

Adjunct Honors Professor – "Nanotechnology in Society" and "Science in Popular Culture" **2007-**
Developed and taught entirely new courses for Honors students throughout several campus schools.
Teaching Assistant – ChNE 251, 253, 317, 454 **2003-2007**
Collaborated on curriculum and exam development, met with studentsduring regular office hours, and graded all written work, including final exams.

National American University, Albuquerque, NM
Assistant Faculty – CHEM 121, MATH 150, 151, **2004-2007**
Created and taught chemistry course. Developed and taught math courses including Algebra, Calculus I-III, Differential Equations, and Linear Algebra.

PROFESSIONAL EXPERIENCE

University of New Mexico, Albuquerque, NM
Research Assistant **2002-2008**
Worked in emerging field combining nanotechnology and cell-biology
Presented research at several national and international conferences (20+ presentations, 4 awards)
Published research in high-impact journals
Designed and maintained BioSafety-approved research lab
Prepared and maintained various funded proposals and grants
Manage and mentor 5 undergraduate students
Engineering-Environmental Management, Albuquerque, NM

Technical Specialist **2000-2002**
Documented and consolidated potentially hazardous air emissions for an entire Air Force base

Sandia National Laboratories, Albuquerque, NM
Technical Intern **1997-2000**
Trained in experimental design utilizing explosives

SELECT PUBLICATIONS

"Cell-Directed Assembly of Lipid-Silica Nanostructures Providing Extended Cell Viability," Science, Jul 21, 2006.

"Confinement-Induced Quorum Sensing of Individual Staphylococcus aureus Bacteria" submitted to Nature Chemical Biology

"Lithography with Life: A New Approach for Integrating Living Cells with Nanotechnology" in prep for submission to Science

SELECT PRESENTATIONS

"Patternable Cell Directed Integration," Materials Research Society Spring Meeting, March 24-28, 2008. San Francisco, CA

"Lithography with Life: A New Means of Patterned Cellular Integration into Self-Assembled Nanostructures." HK IAS – US ICMR Workshop on Advanced Materials, September 12-15, 2007. HKUST, Hong Kong.

"Directing the Self-Assembly of Nanostructured Sol-Gel Films with Living Cells." XIVth International Sol-Gel Conference, September 2-7, 2007, Montpellier, France.

SELECT PATENTS

"Extended Viability Live Vaccines for TB" - Disclosure form submitted

"Live Cell Patterning and Immobilization Techniques" - Disclosure form awaiting signatures.

TECHNOLOGICAL EXPERTISE

Cell-based Devices and Biosensors

Self-assembly and Nanomaterials

Cell-to-Cell Communication

Cell Culture and Maintenance

Scanning Electron Microscopy (SEM)

Confocal Laser Scanning Microscopy (LSM)

Fluorescence Microscopy (Zeiss and Nikon)

Fluorescence Emission Fingerprinting (FEF)

Energy Dispersive Spectroscopy (EDS)

X-Ray and Diffraction and Scattering (XRD, SAXS)

MEMBERSHIPS

American Institute of Chemical Engineers

Materials Research Society

American Chemical Society

Tau Beta Pi Engineering Honor Society

Eva Y. Chi, Ph.D.

Department of Chemical and Nuclear Engineering
Center for Biomedical Engineering
University of New Mexico
222 University Blvd. NE, MSC01 1141, Albuquerque, NM 87131
Phone: 505-277-2263
Fax: 505-277-1979
Email: evachi@unm.edu

EDUCATION

- Ph.D., Chemical Engineering, University of Colorado, Boulder, CO, 2004
- M.S., Chemical Engineering, University of Colorado, Boulder, CO, 2001
- B.S., Chemistry, University of California, Berkeley, CA, 1999
- B.S., Chemical Engineering, University of California, Berkeley, CA, 1999

PROFESSIONAL EXPERIENCE

- **Assistant Professor**, Department of Chemical and Nuclear Engineering and the Center for Biomedical Engineering, University of New Mexico, Albuquerque, NM, 2008 – present
- **Postdoctoral Research Fellow**, Department of Chemistry, Institute for Biophysical Dynamics, and the James Franck Institute, University of Chicago, Chicago, IL, 2004 – 2008

HONORS AND AWARDS

- International Institute for Complex Adaptive Matter Junior Scientist Travel Award, 2007
- Institute for Pure and Applied Mathematics (IPAM) Workshop Travel Award, 2006
- NIH Ruth L. Kirschstein National Research Service Award, 2004-2007
- American Institute of Chemists Graduate Award, 2004
- NIH Leadership Training in Pharmaceutical Technology Fellowship, 2003
- NSF Graduate Research Fellowship, 2001-2004
- U.S. Department of Education Graduate Assistantship in the Areas of National Need, Macromolecular Science and Engineering Fellowship, 2000-2004
- Student Annual Research Symposium Award, 2004
- Graduate Interdisciplinary Certificate in Biotechnology, Interdisciplinary Biotechnology Program, 2003
- Prof. Serge N. Timasheff Award – Excellence in Graduate Studies in the Field of Protein Stability Research, 2002

PEER-REVIEWED PUBLICATIONS

1. SL Frey, **EY Chi**, Arratia C, KYC Lee. Condensing and fluidizing effects of Ganglioside G_{M1} on phospholipid films, (2008) *Biophysical Journal*, **94**: 3047-3064
2. **EY Chi**, C Ege, A Winans, J Majewski, G Wu, K Kjaer, KYC Lee. Lipid membrane templates the ordering and induces the fibrillogenesis of Alzheimer's disease amyloid-beta peptide, (2008) *Proteins*, **72**: 1-24
3. **EY Chi**, SL Frey, KYC Lee. Ganglioside G_{M1}-mediated amyloid-beta fibrillogenesis and membrane disruption, (2007) *Biochemistry*, **46**: 1913-24
4. **EY Chi**, BS Kendrick, JF Carpenter, TW Randolph. Population balance modeling of

aggregation kinetics of recombinant human interleukin-1 receptor antagonist, (2005) *Journal of Pharmaceutical Sciences*, **94**: 2735-2748

5. **EY Chi**, J Weickmann, JF Carpenter, MC Manning, TW Randolph. Heterogeneous nucleation controlled intermittent aggregation of recombinant human platelet-activating factor acetylhydrolase in pharmaceutical formulation, (2005) *Journal of Pharmaceutical Sciences*, **94**: 256-274
6. **EY Chi**, S Krishnan, TW Randolph, JF Carpenter. Physical stability of proteins in aqueous solution: mechanism and driving forces in non-native protein aggregation, (2003) *Pharmaceutical Research*, **20**, 1325-1336
7. **EY Chi**, Krishnan, BS Kendrick, BS Chang, JF Carpenter, TW Randolph. Roles of conformational and colloidal stability in the aggregation of recombinant human granulocyte colony stimulating factor, (2003) *Protein Science*, **12**, 903-913
8. S Krishnan, **EY Chi**, SJ Wood, BS Kendrick, C Li, W Garzon-Rodriguez, J Wypych, TW Randolph, L. Narhi, AL Biere, M Citron, JF Carpenter. Oxidative dimer formation is the critical rate-Limiting step for Parkinson's disease alpha-synuclein fibrillogenesis, (2003) *Biochemistry*, **42**, 829-837
9. S Krishnan, **EY Chi**, JN Webb, BS Chang, D Shan, M Goldenberg, MC Manning, TW Randolph, JF Carpenter. Aggregation of granulocyte colony stimulating factor under physiological conditions: characterization and thermodynamic inhibition (2002) *Biochemistry*, **41**, 6422-6431
10. YS Kim, SP Cape, **EY Chi**, R Raffen, P Wilkins-Stevens, FJ Stevens, MC Manning, TW Randolph, A Solomon, JF Carpenter. Counteracting effects of renal solutes on amyloid fibril formation by immunoglobulin light chains (2001) *Journal of Biological Chemistry*, **276**, 1626-1633

PROFESSIONAL MEMBERSHIPS

- American Institute of Chemical Engineers
- American Chemical Society
- Biophysics Society
- American Association of Pharmaceutical Scientists

Curriculum Vitae

John G. Curro
University of New Mexico Advanced
Materials Laboratory1001 University Blvd.
SEAlbuquerque, NM 87106505-272-7129
505-867-2471 jgcurro@unm.edu

Education

B.ChE.	University of Detroit, Detroit, MichiganChemical Engineering, Summa Cum Laudae, 1965Thesis: "Composition of Graft Copolymers Formed by Electron Irradiation"
Ph.D.	California Institute of Technology, Pasadena, CaliforniaMaterials Science, Minor: Chemical Engineering. 1969Thesis: Excluded Volume Theory of PolymersAdvisors: C. J. Pings and Paul J. Blatz

Experience

2004 – present	University of New MexicoDept. of Chemical & Nuclear EngineeringNational Laboratories Professor
2004 – present	NM Institute of Mining & TechnologyMaterials Department Adjunct Professor
1970 – 2006	Sandia National Laboratories Senior Scientist
1969 -1970	Postdoctoral Research University of Maryland; Advisor: R. W. Zwanzig

Awards and Recognition

Fellow: American Physical Society
Dow Distinguished Lecturer, Northwestern University, 1998-99
ACS Arthur K. Doolittle Award, Div. of Polymer Sci. & Eng. 1998
DOE-BES Award for Excellence in Materials Chemistry 1996
R&D 100 Award 1992
Sandia National Labs Awards for Excellence 1990, 1992, 1996

Professional Activities

Executive Committee – DPOLY, American Physical Society (2002 -2005)
Scientific Advisory Committee – MIT, 1987 –1992
Scientific Advisory Committee -Lawrence Livermore National Lab. 1991-97
Scientific Advisory Committee – Lawrence Berkeley National Lab. 1998
Editorial Advisory Board -Macromolecules 1989 -1992
Editorial Advisory Board – Comp. & Theoretical Polymer Science 1989 – 2000

Research Interests

Molecular modeling of polymers using theoretical methods and computer simulation with emphasis on the structure and properties of polymers at the nanoscale

Publications

137 articles in peer-reviewed journals

Selected recent publications:

S. Mendez, J. G. Curro, J. D. McCoy, G. P. Lopez, *Computational Modeling of the Temperature-Induced Structural Changes in Poly(n-isopropyly acrylamide) with Self-Consistent Field Theory*,Macromolecules, **38**, 174 (2005).

D. R. Rottach, J. G. Curro, J. Budzien, G. S. Grest, C. Svaneborg, R. Everaers, *Molecular Dynamics Simulations of Polymer Networks Undergoing Sequential Crosslinking and Scission Reactions,* Macromolecules, **40**, 131 (2007).

M. Tsige, J. G. Curro, G. S. Grest, *Packing of Poly(tetrafluoroethylene) in the Liquid State:Molecular Dynamics Simulation and Theory*, J. Chem. Phys., **129**, 214901(2008

Selected Reviews:

K. S. Schweizer and J. G. Curro, *Integral Equation Theories of the Structure, Thermodynamics, and Phase Transitions of Polymer Fluids*, Adv. Chem. Phys. **98**, 1, Ed. I Prigogine, S. A. Rice, John Wiley & Sons, Inc. (1997).

D. Heine , G. S. Grest, and J. G. Curro, *Structure of Polymer Melts and Blends:Comparison of Integral Equation Theory and Computer Simulation*, Adv. Polym. Sci., **176**, 211 (2004).

Graduate Students Advised

S. Mendez, Ph.D., D. Rottach, Ph.D. University of New Mexico

Postdoctoral Associates Advised

K. G. Honnell, J. D. McCoy, J. D. Melenkevitz, J. P. Donley, J. J. Rajasekaran, J. D.Weinhold, M. Pütz, E. Jaramillo, A. Frischknecht, S. Nath, J. Budzien

Biographical Sketch Abhaya K. Datye

A. Professional Preparation

B.S., Chemical Engineering, 1975, Indian Institute of Technology, Bombay, India.
M.S., Chemical Engineering, 1980, University of Cincinnati, "Electrical Conductivity of Foams."
Ph.D., Chemical Engineering, 1984, University of Michigan, "Bimetallic Ru-Au Catalysts: Characterization and Reactivity."

Honors and Awards:

NSF Excellence award, 2008**, Industrial Innovation and Partnerships Division**
University of New Mexico **Distinguished Professor,** 2007**,** School of Engineering, **Senior Teaching Excellence Award** 2007**, Best paper Materials Science**, Microscopy Society of America, 2006, **Senior Research Excellence Award**, 1998, **Junior Research Excellence Award,** 1989, Chemical & Nuclear Engr. Graduate students, UNM, **Outstanding Teacher Award**, 1988, **Presidential Lectureship**, 1986-88, Univ. of New Mexico
Outstanding graduate student, 1982, Department of Chemical Engineering, Michigan

B. Appointments

Academic:

1984 – present, The University of New Mexico, Albuquerque, NM. 87131, current title – Distinguished Professor
2007 – present, Director of the Nanoscience & Microsystems graduate program
2002 – 2007, Associate Chair, Department of Chemical and Nuclear Engineering
1994 – present, Director, Center for Micro-engineered Materials (CMEM), UNM Level III center
1994 – 1999, Director NSF/IUCRC Center for Microengineered Materials
1999 – 2004, Executive Director, NSF/IUCRC Ceramic and Composite Materials Center
2004 – 2007, Site Director, NSF/IUCRC Ceramic and Composite Materials Center

Industrial:

1976 - 78, Hindustan Organic Chemicals, Rasayani, India, Scientific Officer.
1975 - 76, Hindustan Lever Ltd., Research Center, Bombay, India, Research Assistant.

Sabbaticals and Fellowships

University of Poitiers, France, Visiting Professor; 2004. **University of Witwatersrand, South Africa** Honorary Professor, 2003 – 2007; **Haldor Topsøe**, Lyngby, Denmark, 1999; **Oak Ridge National Lab**, summer 1994. **BP Research Center**, Sunbury on Thames, UK, 1991.

C. Publications and Presentations: (232 publications, 1 patent, 215 presentations, 100 invited talks)

Recent invited talks: Keynote lecture at Europacat VI at Innsbruck, Austria Sept 2003; Gordon Research Conference on Catalysis, New London, NH, June 2004; North American Catalysis Society, Philadelphia, 2005; NSF workshop on In-situ Electron Microscopy, Tempe, AZ, Jan 2006; Michigan Catalysis Society, Midland, MI, May 2006, invited keynote speaker; CRC conference on in-situ spectroscopy, Hokkaido, Japan, Sept 2007, Eindhoven University, Netherlands, Nov. 2008.

PUBLICATIONS (10 recent, out of 232) H-index 33

1. Szabo, E.G., M. Hegedus, F. Lonyi, A. Szegedi, A.K. Datye, and J.L. Margitfalvi, Preparation, characterization and activity of Au/Al2O3 catalysts modified by MgO. Catal. Commun. FIELD Full Journal Title:Catalysis Communications, 2009. 10(6): p. 889-893.
2. Moodley, D.J., J. van de Loosdrecht, A.M. Saib, M.J. Overett, A.K. Datye, and J.W. Niemantsverdriet, Carbon deposition as a deactivation mechanism of cobalt-based Fischer-Tropsch synthesis catalysts under realistic conditions. Appl. Catal., A FIELD Full Journal Title:Applied Catalysis, A: General, 2009. 354(1-2): p. 102-110.
3. Switzer, E.E., T.S. Olson, A.K. Datye, P. Atanassov, M.R. Hibbs, and C.J. Cornelius, Templated Pt-Sn

electrocatalysts for ethanol, methanol and CO oxidation in alkaline media. Electrochimica Acta, 2008.

4. Naicker, T., A.K. Datye, and H.B. Friedrich, A comparative study of Os-hydrotalcites for the cis-dihydroxylation of cyclohexene. Applied Catalysis A: General, 2008. 350(1): p. 96-102.
5. Lebarbier, V., R. Dagle, T. Conant, J.M. Vohs, A.K. Datye, and Y. Wang, CO/FTIR spectroscopic characterization of Pd/ZnO/Al2O3 catalysts for methanol steam reforming. Catalysis Letters, 2008. 122(3-4): p. 223-227.
6. Karim, A.M., T. Conant, and A.K. Datye, Controlling ZnO morphology for improved methanol steam reforming reactivity. Physical Chemistry Chemical Physics, 2008. 10(36): p. 5584-5590.
7. Houk, L., A. DeLaRiva, R. Goeke, P. Fanson, and A. Datye, Support effects on adatom emission from nanoparticles. Microscopy and Microanalysis, 2008. 14(SUPPL. 2): p. 182-183.
8. Gu, Y., J. St-Pierre, R. Goeke, A. Datye, and P. Atanassov, Aging studies of Pt/glassy carbon model electrocatalysts. ECS Trans. FIELD Full Journal Title:ECS Transactions, 2008. 16(2): p. 355-360.
9. Goeke, R.S. and A.K. Datye, Oxide support modification during Pd particle aging at elevated temperatures. Microscopy and Microanalysis, 2008. 14(SUPPL. 2): p. 176-177.
10. Gabaldon, J.P., M. Bore, and A. Datye, Imaging of gold nanoparticles within mesoporous silica supports. Microscopy and Microanalysis, 2008. 14(SUPPL. 2): p. 178-179.

D. Synergistic Activities

As director of a NSF/Research Experiences for Undergraduates Site Program, I have organized a summer program (since 1995) for students from other universities to spend 10 weeks on campus working with researchers at our center. During the summers of 1999- 2001, we also brought 3 high school teachers each year into our summer program via the RET (Research Experiences for Teachers) program funded by NSF. As the site director for the NSF/EPSCOR program in Nanoscience at UNM, I have helped organize an outreach program that involves workshops aimed at high school teachers. We secured funding from a foundation to provide kits that teachers can take back to their classes. We have developed a new interdisciplinary curriculum in Nanoscience and Microsystems, as part of the NSF/IGERT program.

Professional Society membership, Offices:

Elected Vice Chair of the Gordon Research Conference on Catalysis for 2008 and Chair for 2010. Co-chair, North American Catalysis Society Meeting, Catalyst Characterization session, Houston 2007 Editorial Board of Catalysis Letters and Catalysis Today, 2004- ,Editorial Board of Applied Catalysis, 2001-2004; North American Catalysis Society, Program co-chair, 1995; representative to the International Congress of Catalysis 2000, Western States Catalysis Society, Past President, representative to the Board of the North America Catalysis Society1999-2005. Microscopy Society of America, session chair 1986; International Congress of Electron Microscopy, Cancun 1998, session chair, American Chemical Society, American Vacuum Society, New Mexico Chapter, Chapter Chair.

E. Collaborators and Other Affiliations

i. Collaborators (in alphabetical order)

Larry Allard, Jeff Brinker, Neil Coville, Bob Davis, Jim Dumesic, Poul Hansen, Charles Kappenstein, Karl C. C. Kharas, Matt Neurock, Robert Schløgl, Brent Shanks, Stig Helveg, John Vohs, Yong Wang.

ii. Graduate Advisors

Johannes Schwank, University of Michigan, Ph. D, Robert Lemlich, University of Cincinnati, M. S.

iii. Thesis Advisor and Post-doctoral Scholar Sponsor

Graduate Students Advised: 22 Ph. D, 22 M. S. *Present Research group* (6 grad students, 4 post-docs, 3 undergraduates) Andrew DeLaRiva, Levi Houk, Patrick Burton, Ron Goeke, Eric Petersen; Maria Leyva *undergrad students* Loren Baca, Ehren Baca; Angelica Sanchez *post-docs* Vanessa Lebarbier, Barr Halevi, Siva Challa and Hien Pham; *Recent students graduated*: Jaime Bravo, Ph. D. 2005, Hugo Zea, Ph. D. 2005, Ganesh Vanamu, Ph. D. 2005, Travis Conant, M.S. 2005, Marcus Smith, M.S. 2005, Thomas Hansen, Ph.D. 2006, Ayman Karim, Ph. D. 2006, John Gabaldon, M.S. 2007, Travis Conant, PhD 2008, Elise Switzer, PhD 2008, John Iwaszek, M.S. 2008.

BIOGRAPHICAL SKETCH: ELIZABETH L. (HEDBERG) DIRK

EDUCATION

University of Colorado, Boulder, Postdoctoral Fellow, 2004-2006
Rice University, Houston, TX, Bioengineering, PhD, 2004
University of California, Santa Barbara, B.S., Chemical Engineering (concentration: Biomaterials), High Honors, BS, 1997

PROFESSIONAL EXPERIENCE

Assistant Professor, Department of Chemical & Nuclear Engineering and Department of Chemistry; University of New Mexico, NM, 2006-present
Special Topics Instructor, Bio-separations, Chemical Engineering Separations and Mass Transfer, University of Colorado, Boulder, 2005
Visiting Researcher, University Medical Center Nijmegen, Department of Biomaterials, Nijmegen, The Netherlands: 2002– 2003
Adjunct Researcher, Chrysalis Biotechnology, Inc., Galveston, TX/ OrthoLogic, Corp., Tempe, AZ: 2000 - 2004
Undergraduate Research Advisor, Rice University, Houston, TX: 2001 - 2004
Graduate Teaching Assistant, Rice University, Houston, TX: 2000 - 2001
Scientist I, Clorox Services Company, Pleasanton, CA: 1997 – 1998

PUBLICATIONS

P.Q. Ruhe, E.L. Hedberg, P.H.M. Spauwen, J.A. Jansen, A.G. Mikos, "Porous Poly(DL-Lactic-co-Glycolic Acid)/Calcium Phosphate Cement Composites for Bone Tissue Reconstruction," Tissue Engineering, 12, 789-800, 2006.

E.L. Hedberg, H.C. Kroese-Deutman, C.K. Shih, R.S. Crowther, D.H. Carney, A.G. Mikos, J.A. Jansen, "In Vivo Degradation of Porous Poly(Propylene Fumarate)/Poly(DL-Lactic-co-Glycolic Acid) Composite Scaffolds," Biomaterials, 26, 4616-4623, 2005.

P.Q. Ruhe, E.L. Hedberg, N.T. Padron, P.H.M. Spauwen, J.A. Jansen, A.G. Mikos, "Biocompatibility and degradation of Poly(DL-Lactic-co-Glycolic Acid)/Calcium Phosphate Cement Composites," Journal of Biomedical Materials Research, 74A, 533-544, 2005.

E.L. Hedberg,, C.K. Shih, M.D. Timmer, J.J. Lemoine, M.A.K. Liebschner, J.A. Jansen, A.G. Mikos, "In Vitro Degradation of Porous Poly(Propylene Fumarate)/(Poly(DL-Lactic-co-Glycolic Acid) Composite Scaffolds," Biomaterials, 26, 3215-3225, 2005.

E.L. Hedberg, H.C. Kroese-Deutman, C.K. Shih, R.S. Crowther, D.H. Carney, A.G. Mikos, J.A. Jansen, "Effect of Varied Release Kinetics of the Osteogenic Thrombin Peptide TP508 from Biodegradable, Polymeric Scaffolds on Bone Formation In Vivo," Journal of Biomedical Materials Research, 72, 343-353, 2005.

E.L. Hedberg, H.C. Kroese-Deutman, J.J. Lemoine, C.K. Shih, M.J. Miller, A.W. Yasko, R.S. Crowther, M.A.K. Liebschner D.H. Carney, A.G. Mikos, J.A. Jansen, "A Comparative Analysis of Radiography, Micro-Computed Tomography, and Histology for Bone Tissue Engineering," Tissue Engineering, 11, 1356-1367, 2005.

E.L. Hedberg, C.K. Shih, L. Solchaga, A.I. Caplan, A.G. Mikos, "Controlled Release of Hyaluronan Acid Oligomers from Biodegradable Polymeric Microparticles," Journal of Controlled Release, 100, 257-266, 2004.

P.Q. Ruhe[±], E.L. Hedberg[±], N.T. Padron, P.H.M. Spauwen, J.A. Jansen, A.G. Mikos, "rhBMP-2 Release from Injectable Poly(DL-Lactic-co-Glycolic Acid)/Calcium Phosphate Cement Composites," The Journal of Bone and Joint Surgery 85A, 75-81, 2003. [±] Both authors contributed equally.

E.L. Hedberg, A. Tang, R.S. Crowther, D.H. Carney, A.G. Mikos, "Controlled Release of an Osteoinductive Peptide from Injectable Biodegradable Polymeric Composites," Journal of Controlled Release 84, 137-150, 2002.

Q. Liu, E.L. Hedberg, Z. Liu, R. Bahulekar, R.K. Meszlenyi, A.G. Mikos, "Preparation of macroporous poly(2-hydroxyethyl methacrylate) hydrogels by enhanced phase separation," Biomaterials, 21, 2163-2169, 2000.

TOTAL PUBLICATIONS IN CAREER (2000 - present)

11 refereed publications, 3 book chapters, 2 patents awarded, 1 patent pending.

SYNERGISTIC ACTIVITIES IN PAST FIVE YEARS

NSF Review Panels, CBET 2008-2009
AIChE Session Chair, 2008 – present
AIChE UNM student chapter mentor, 2007 - present
Reviewer for: Acta Biomaterialia, Biomaterials, Journal of Controlled Release, Journal of Biomedical Materials Research, Journal of the American Society for Artificial Organs, Nature Biotechnology, Pharmaceutical Research, Polymer, Tissue Engineering
Member: American Institute of Chemical Engineers, Society for Biomaterials, Materials Research Society, American Chemical Society, Biomedical Engineering Society

RESEARCH COLLABORATORS

David Mooney, K. Kit Parker: Harvard University
Katherine Bogart, Kamyar Rahimien: Sandia National Laboratories
Helen Hathaway: UNM Health Sciences Center
Gabriel P. Lopez, UNM Center for Biomedical Engineering

RESEARCH MENTORS

Graduate: Dr. Antonios G. Mikos, Rice University, Houston, TX
Postdoctoral: Dr. Kristi S. Anseth, University of Colorado, Boulder

CURRENT STUDENTS

Ulises A. Martinez, graduate, Chemical Engineering

Anne Hellebust, senior, Chemical Engineering
Jose Cornejo, senior, Chemical Engineering
Jared Funston, sophomore, Chemical Engineering

TOTAL NUMBER OF STUDENTS ADVISED: 6 undergraduate, 2 graduate
TOTAL NUMBER OF POSTDOCS ADVISED: 0

HONORS AND AWARDS

Ralph E. Powe Junior Faculty Enhancement Award, Oakridge Association of Universities, 2008-2009
Student Travel Grant, Biomedical Engineering Society, 2003
Student Award for Excellence in Tissue Engineering, Tissue Engineering Special Interest Group, Society for Biomaterials, 2002,
Student Travel Grant, Materials Research Society, 2001
NIH Biotechnology Training Grant Trainee, 1999-2000; 2001-2002

JULIA E. FULGHUM
Office of the Vice President for Research
Scholes Hall, Rm. 327
MSC05 3480
University of New Mexico
Albuquerque, New Mexico 87131-0001

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Email: jfulghum@unm.edu
Fax: (505) 277-5271

Education

Ph.D. Analytical Chemistry, University of North Carolina, 1987
M.S. Analytical Chemistry, Cornell University, 1983
B.S. Chemistry with Highest Honors, University of North Carolina 1981

Professional Experience

Vice President for Research, UNM, December 2008 –
Interim Vice President for Research, UNM, July 2008-December 2008
Chair, Chemical and Nuclear Engineering, UNM, August 2002 – July 2008
Professor, Chemical and Nuclear Engineering, UNM, August 2002
Professor, Chemistry Department, KSU, August 2000
Honors College Faculty Member, KSU, January 2000
Graduate Coordinator, Chemistry Department, KSU, August 1997- July 2000.
Visiting Scientist, National Renewable Energy Laboratory, Golden, CO: September 1996 - June 1997.
Adjunct Professor, Chemical Physics Interdisciplinary Program, KSU: July 1995
Associate Professor, Chemistry Department, KSU: August 1994
Graduate Coordinator, Chemistry Department, KSU: August 1990 - August 1994.
Assistant Professor, Chemistry Department, Kent State University; August 1989
Postdoctoral Associate, Microelectronics Center of North Carolina; January 1988 - July 1989.
Postdoctoral Associate and Instructor, Chemistry Department, University of North Carolina; July 1987 - June 1988

Honors

Fellow	American Vacuum Society (AVS), 2008
Distinguished Teacher Award	College of Arts and Sciences, KSU, 2001
Outstanding Faculty Mentor	Teaching Scholars Program, KSU 2001

Professional Offices and Editorial Boards

Director, Governing Board, Council for Chemical Research, 2007-2009
Chair, Professional Leadership and Outreach Committee, AVS 2007-2010
Chair, NM AVS 2007-2008
Member of the Editorial Advisory Board for *Surface and Interface Analysis*
Member of the Editorial Advisory Board for *The Journal Of Electron Spectroscopy and Related Phenomena*
Chair of the External Advisory Board of the National ESCA and Surface Analysis Center for Biomedical Problems (NESAC/BIO), U. Washington, Seattle, WA. (1992-2007)
Vice-Chair, NM AVS 2006-2007
Program Chair for "Surface Analysis '06" a combined meeting of the Applied Surface Science Division of the AVS and the annual symposium of the NM AVS Chapter
Nominations Committee, Council for Chemical Research, 2004
Member-at-Large of Executive Committee, Applied Surface Science Division of the American Vacuum Society, 2003-2006
Executive Committee member, NM AVS, 2003-2006

Other Professional Activities

President of the New Mexico Consortium (NMC), 2008

Member of the Board of Directors of the Science and Technology Corporation (STC.UNM), 2008

Member of National Research Council's Committee on "Revealing Chemistry through Advanced Chemical Imaging," report published in Spring, 2006

Women in Engineering Leadership Institute

Member of Program Committee for the 8th (1999), 9th (2001) 10th (2003), 11th (2005) and 12th (2007) Topical Conferences on Quantitative Surface Analysis

Publications (2005-2008)

1. "Predictive Modeling of Electrocatalyst Structure Based on Structure-to-Property Correlations of X-ray Photoelectron Spectroscopic and Electrochemical Measurements," Artyushkova, K.; Pylypenko, S.; Olson, T.S., Fulghum, J.E. and Atanassov, P.; *Langmuir*, 24, 9082-9088, 2008.
2. "XPS Structural Studies of Nano-Composite Non-Platinum Electrocatalysts for Polymer Electrolyte Fuel Cells," Artyushkova, K.; Levendosky, S.; Atanassov, P. and Fulghum, J.; *Topics in Catalysis*, 46, 263-275, 2007.
3. "Residual Stress of Focused Ion Beam-Exposed Polycrystalline Silicon,", K.M. Archuleta, D.P. Adams, M.J. Vasile, and J.E. Fulghum, in Focused Ion Beams for Analysis and Processing, edited by W. Moberly-Chan, H. Colijn, R. Langford, A. Marshall (Mat. Res. Soc. Symp. Proc. 983E, Warrendale, PA, 2007), paper # 0983-LL08-10.
4. "Visualizing Chemistry: The Progress and Promise of Advanced Chemical Imaging," co-author as
   a member of the National Research Council's Committee on Revealing Chemistry through Advanced Chemical Imaging, National Academies Press, Washington, D.C., 2006.
5. "Ion Beam Alignment of Nematic Liquid Crystal on MEH-PPV-layers," Pylypenko, S., Artyushkova, K., Fulghum, J.E., Su, L., West, J., and Reznikov, Y, *Molecular Crystals and Liquid Crystals*, 454, 167-177, 2006.
6. "Angle-Resolved Imaging of Polymer Blend Systems: From Images to a 3D Volume of the Material Morphology," Artyushkova, K.; Fulghum, J.E., *J. Elec. Spec. Rel. Phenom.*, 149, 51-60, 2005.
7. "Potential Directed Assembly of Aryl Iodonium Salts onto Silicon Hydride {100}Terminated Surfaces," Dirk, Shawn, M.; Pylypenko, Svitlana; Howell, Stephen W.; Fulghum, Julia E.; and Wheeler, David R.; *Langmuir*, 21, 10899-10901, 2005.
8. "Orientation of 5CB Molecules on Aligning Substrates Studied by Angle Resolved, X-ray Photoelectron Spectroscopy," Artyushkova, K., Fulghum, J.E., Reznikov, Y., and West, J.L., *Molecular Crystals and Liquid Crystals*, 438, 1769-1777, 2005.
9. "Oriented Monolayers of Lyotropic Chromonic Liquid Crystal," Schneider, T., Artyushkova, K., Fulghum, J.E., Broadwater, L., Smith, A, and Lavrentovich, O.D.; *Lamgmuir*, 21, 2300-2307, 2005.

Dissertations and Theses Directed

Undergraduate Honors Thesis	2
M.S. Theses	4
Ph.D. Dissertations	10

Publications, Conference Presentations and Selected Presentations Summary

Publications	47
Invited International and National Conference Presentations	17
Contributed International and National Conference Presentations	96
Special Topic Presentations	10

CURRICULUM VITAE

Steven W. Graves, Ph. D.

2041G Centennial Engineering Center • University of New Mexico• Albuquerque, NM 87131• (505) 277-2043 • graves@unm.edu

EDUCATION

Ph. D. Biochemistry, Microbiology and Molecular Biology, 1998, The Pennsylvania State University, University Park, PA

B.A. Biochemistry and Molecular Biology (Double Major), 1991, University of Colorado, Boulder, CO

PROFESSIONAL EXPERIENCE

2008 – Present **Associate Director**
Center for Biomedical Engineering, University of New Mexico, Albuquerque, NM

2008 – Present **Associate Professor**
Chemical and Nuclear Engineering Department, University of New Mexico, Albuquerque, NM

2008 – Present **Affiliate Scientist**
Los Alamos National Laboratory, Bioscience Division, Los Alamos, NM

2007 – 2008 **Team Leader, Optical Spectroscopy and Instrumentation**
Biosciences Division, Los Alamos National Laboratory, Los Alamos, NM

2003 – Present **Adjunct Assistant Professor**
Biochemistry Department, University of New Mexico, Albuquerque, NM

2002 – 2008 **Technical Staff Member**
Biosciences Division, Los Alamos National Laboratory, Los Alamos, NM

1999 – 2002 **Post-Doctoral Fellow**
Biosciences Division, Los Alamos National Laboratory, Los Alamos, NM

1998 – 1999 **Applications Specialist**
KinTek Corporation, Austin, TX

SELECTED PUBLICATIONS (of 24)

Graves S.W., Johnson A.A. and Johnson K.A. (1998). Expression, purification, and initial kinetic characterization of the large subunit of the human mitochondrial DNA polymerase. *Biochemistry*, 37(17) 6050-6058

Johnson, A.A., Tsai, Y., **Graves S.W**. and Johnson, K.A. (2000) Human mitochondrial DNA polymerase holoenzyme: Reconstitution and characterization. *Biochemistry,* 39(7), 1702-1708

Patterton, H.G. and **Graves, S**. (2000) DNAssist: the integrated editing and analysis of molecular biology sequences in Windows. *Bioinformatics,* 16(7) 652-653

Graves, S.W., Habbersett, R.C. and Nolan, J.P. (2001) A dynamic inline sample thermoregulation unit for flow cytometry. *Cytometry,* 43(1), 23-30

Graves, S. W., Nolan, J. P., Jett, J. H., Martin, J. C.and Sklar, L.A. (2002) Nozzle design parameters and their effects on rapid sample delivery in flow cytometry. *Cytometry* 47(2):127-37

Chigaev A, Zwartz G, **Graves SW**, Dwyer DC, Tsuji H, Foutz TD, Edwards BS, Prossnitz ER, Larson RS, Sklar LA. (2003) Alpha4beta1 integrin affinity changes govern cell adhesion. J Biol Chem. Oct 3;278(40):38174-82.

Goddard G, Martin JC, **Graves SW**, Kaduchak G. (2006) Ultrasonic particle-concentration for sheathless focusing of particles for analysis in a flow cytometer. Cytometry A. Feb;69(2):66-74.

Saunders MJ, Kim H, Woods TA, Nolan JP, Sklar LA, Edwards BS, **Graves SW** (2006).Microsphere - based protease assays and screening application for lethal factor and factor Xa. Cytometry A. May;69(5):342-52.

Deshpande A, Hammon RJ, Sanders CK, **Graves SW**. (2006) Quantitative analysis of the effect of cell type and cellular differentiation on protective antigen binding to human target cells. FEBS

Lett. Jul 24;580(17):4172-5.

Edwards, B.S., Young, S. M. , Saunders M. J., Bologa C., Oprea T. I., Ye R. D., Prossnitz E. R., **Graves S.W.**, and Sklar L.A., High-throughput flow cytometry for drug discovery, Expert Opin. Drug Discov. (2007) 2(5):1-12

Goddard G.R., Sanders C., Martin J.C., Kaduchak G., **Graves S.W**. Analytical performance of an ultrasonic particle focusing flow cytometer, Anal. Chem., 2007. Nov 15;79(22):8740-6.

Watson, D. A., Brown, L. O., Graham, D. A., Naivar, M. A., **Graves, S. W.**, Doorn, S. K., Nolan J. P., A flow cytometer for the measurement of Raman spectra. *Cytometry Part A. 2008 Feb;73(2):119-28*

RECENT PRESENTATIONS (*INVITED)

***Graves, S. W.** Bringing the power of flow cytometry to critical applications in the clinic and biomedical research, January 15th, 2009 Center for Integrated Nanotechnologies, Los Alamos National Laboratory

Graves S.W., Kaduchak G., Goddard G. R., Habbersett, R.C. Ward, M.D., Martin J. C., Naivar M. A. Low Cost Hand-Portable Flow Cytometry International Society of Analytical Cytology 23rd Annual Conference, Quebec City, Quebec, Canada, May 20-24th, 2006.

***Graves, S.W.** Low-cost portable flow cytometry. The Fall 2007 Seminar Series in the Chemical Engineering Department, September 7, 2007. Colorado School of Mines.

***Graves, S. W.** Measurement and analysis of nano scale materials by flow cytometry. 1st Annual Symposium: Integrating Nanotechnology with Cell Biology and Neuroscience, August 15, 2007, The University of New Mexico.

TEACHING AT UNM

Spring 2009	Developed a special topics course "Biomacromolecular Engineering" (CHNE 499/515-003) with the focus of bioengineering of proteins, nucleic acids, and carbohydrates.
Spring 2009	Biomedical Engineering Seminar (CHNE 406/506)
Fall 2008	Biomedical Engineering Seminar (CHNE 406/506)

TRAINING (CURRENT STUDENTS AND POST-DOCTORAL RESEARCH ASSOCIATES)

Ph. D. Students	**Matthew Saunders** (Ph. D program in Biomedical Sciences Graduate Program) – expected graduation in summer of 2009 **Carl Brown**, (Ph. D program in Biomedical Sciences Graduate Program) – first year student in 2008-2009 **Samantha Schwartz,** (Ph. D. program in Nanoscience and Microsystem), - rotating through my lab in a joint project with Darko Stefanovic of Computer Science.
Undergraduates	**Marissa R Anderson**, (Freshman intending to major in Chemical Engineering), **Rath Chaleunphonh**, (Freshman intending to major in Chemical Engineering).
Post-Docs	**Robert Applegate Jr., Ph. D.** – Project is developing field based manipulation methods for large particle sorting in flow cytometry.

ACTIVE RESEARCH FUNDING

NIH RR020064 R21/R33 Low cost portable flow cytometry

Role – PI, 8/15/05-7/31/07 --- R33 Phase 8/01/07- 7/31/10 $350K/year

This is a grant to develop a low cost portable flow cytometer for use in resource poor settings.

NIH RR01315-25 The National Flow Cytometry Resource

Role Co-I, 7/01/07-6/30/12 Project Lead on – Next Generation Large Particle Sorting, Current UNM Subcontract of $250K/year. We are developing large particle sorting technology for many purposes but primarily for screening of a variety of combinatorial libraries.

SANG M. HAN

Education and Training

University of California – Berkeley, Chemical Engineering, B.S., 1988 – 1992
University of California – Santa Barbara, Chemical Engineering, Ph.D., 1993 – 1998
University of California – Berkeley, Surface Science, Post-doctoral Research, 1998 – 1999
Lam Research Corporation, CA, Plasma Diagnostics, Post-doctoral Research, 1999 – 2000

Research and Professional Experience

Associate Professor; Department of Chemical and Nuclear Engineering; University of New Mexico, NM (7/06 – present)
Assistant Professor; Department of Chemical and Nuclear Engineering; University of New Mexico, NM (4/00 – 7/06)
Post-doctoral Researcher; Lam Research Corporation, Fremont, CA (11/99 – 4/00)
Post-doctoral Researcher; U. C. Berkeley, CA (11/98 – 10/99)
Graduate Research Assistant; U. C. Santa Barbara, CA (9/93 – 10/98)
Visiting NSF Scholar; Seoul National University, Korea (8/96 – 10/96)
Visiting NSF Scholar; Tokyo Institute of Technology, Japan (6/96 – 8/96)

Select Publications

1. Youn-Jin Oh, Thomas C. Gamble, Darin Leonhardt, Dimiter N. Petsev, Cornelius F. Ivory, Chan-Hwa Chung, Steven R. J. Brueck, Gabriel P. Lopez, and Sang M. Han, "Monitoring FET Flow Control and Wall Adsorption of Charged Fluorescent Dye Molecules in Nanochannels Integrated into a Multiple Internal Reflection Infrared Waveguide," *Lab on a Chip*, **8**, 251-258 (2008).
2. Qiming Li, Joshua L. Krauss, Stephen Hersee, and Sang M. Han, "Understanding the Interaction of Ge with Chemical and Thermal SiO_2 for Selective Growth of Ge on Si by Molecular Beam Epitaxy," *J. Phys. Chem.* C, **111**, 779-786 (2007).
3. Kyle J. Solis, Lance R. Williams, Brian S. Swartzentruber, and Sang M. Han, "Adatom Pair Chain Structures: Metastable Precursors to Island Formation on SiGe 2xN Alloy," *Surf. Sci.*, **601**(1), 172-177 (2006).
4. Qiming Li and Sang M. Han, "Formation of Epitaxial Ge Nanorings on Si by Self-assembled SiO_2 Particles and Touchdown of Ge Through a Thin Layer of SiO_2," *MRS Proc.*, **921**, 0921-T02-04 (2006).
5. Qiming Li, Belliappa Pattada, Steve R. J. Brueck, Stephen Hersee, and Sang M. Han, "Morphological Evolution and Strain Relaxation of Ge Islands Grown on Chemically Oxidized Si(100) by Molecular Beam Epitaxy," *J. Appl. Phys.* **98**, 073504 (2005).
6. Madhava Kosuri, Henry Gerung, Qiming Li, Sang M. Han, Paulo Herrera, and Jason Weaver "Vapor-Phase Adsorption Kinetics of 1-Decene on Hydrogenated Si(111)," *Surf. Sci.* **596**, 21-38 (2005).
7. Qiming Li, Ying-Bing Jiang, Joshua L. Krauss, Huifang Xu, Steven R. J. Brueck, Stephen Hersee, and Sang M. Han, "Heteroepitaxy of high-quality Ge on Si by nanoscale seed pads grown through a SiO_2 interlayer," *Proc. SPIE – Int. Soc. Opt. Eng.*, **5734**, 75-82 (2005).
8. Madhava R. Kosuri, Roya Cone, Qiming Li, Sang M. Han, Bruce C. Bunker, and Thomas M. Mayer, "Adsorption Kinetics of Alkanethiol Self-Assembly on Ge(111)," *Langmuir*, **20**(3), 835 (2004).
9. Qiming Li, Ying-Bing Jiang, Huifang Xu, Steve Hersee, and Sang M. Han "Heteroepitaxy of high quality Ge on Si by nanoscale Ge seeds grown through a thin layer of SiO_2," *Appl. Phys. Lett.*, **85**(11), 1928 (2004) and *Virtual Journal of Nanoscale Science & Technology*, October 4 (2004).
10. Qiming Li, Sang M. Han, Steven R. J. Brueck, Stephen Hersee, Ying-Bing Jiang, and Huifang Xu, "Selective growth of Ge on Si(100) through vias of SiO_2 nanotemplate using solid source molecular beam epitaxy," *Appl. Phys. Lett.*, **83**(24), 5032 (2003).
11. Madhava R. Kosuri, Henry Gerung, Sang M. Han, Bruce C. Bunker, and Thomas M. Mayer, "Vapor-phase Adsorption Kinetics of 1-Decene on H-terminated Si(100)," *Langmuir* **19**(22), 9315 (2003).

Synergistic Activities

- Executive Committee Member in Electronic Materials and Processing Division (EMPD) of American Vacuum Society (2006 – present).
- Chair of Area 8e in Materials Engineering and Sciences Division (MESD) of American Institute of Chemical Engineers (AIChE) (2005 – 2006).
- Chair of New Mexico AVS Chapter (2005 – 2006).

Patents

- Sang M. Han, "Surface Corrugation on Internal Reflection Infrared Waveguide for Enhanced Detection Sensitivity and Selectivity," U.S. Patent No. 7,200,311 was issued on April 3, 2007.
- Qiming Li and Sang M. Han, "Ultra-Thin High-Quality Ge on Si by Low-Temperature Epitaxy and Post-Growth Annealing," U.S. Patent Application 11/835,855 was filed on August 8, 2007.
- Qiming Li and Sang M. Han, "Nanoheteroepitaxy of Ge on Si as a Foundation for Group III-V and II-VI Integration," U.S. Patent Application 11/260,231 was filed on October 28, 2005.
- Qiming Li and Sang M. Han, "Threading-dislocation-free nanoheteroepitaxy of Ge on Si using self-directed touch-down of Ge through a thin SiO_2 layer," U.S. Patent Application 10/935,228 was filed on September 8, 2004.
- Younjin Oh, Danny Bottenus, Cornelius F. Ivory, and Sang M. Han, "Separation and Extreme Size-Focusing of Nanoparticles through Nanochannels Based on Controlled Electrolytic pH Manipulation," U.S. Provisional Patent Application 60/922,676 was filed on April 10, 2007.
- Steve R. J. Brueck, Sang M. Han, Cornelius F. Ivory, Gabriel P. Lopez, and Dimiter N. Petsev, "Nanofluidics for Bioseparation and Analysis," U.S. Patent Application 11/184,540 was filed on July 19, 2005.

Collaborators & Other Affiliations

(i) Collaborators

Dr. Timothy J. Boyle, Sandia National Laboratories, Albuquerque, NM
Prof. Jeffrey Brinker, University of New Mexico, Albuquerque, NM
Prof. Steve R. J. Brueck, University of New Mexico, Albuquerque, NM
Dr. Malcolm S. Carroll, Sandia National Laboratories, Albuquerque, NM
Prof. Stephen Hersee, University of New Mexico, Albuquerque, NM
Prof. Cornelius F. Ivory, Washington State University, Pullman, WA
Prof. Gabriel P. López, University of New Mexico, Albuquerque, NM
Dr. Brian S. Swartzentruber, Sandia National Laboratories, Albuquerque, NM

(ii) Graduate and Postdoctoral Advisors

Prof. Eray S. Aydil; University of Minnesota, Minneapolis, MN
Dr. Neil Benjamin; Lam Research Corporation, Fremont, CA
Prof. Steven P. DenBaars, University of California Santa Barbara, Santa Barbara, CA
Prof. Evelyn L. Hu, University of California Santa Barbara, Santa Barbara, CA
Prof. Roya Maboudian; University of California Berkeley, Berkeley, CA
Prof. Dimitrios Maroudas; University of Massachusetts – Amherst, Amherst, MA
Prof. David J. Pine; New York University, New York, NY

(iii) Thesis Advisor and Postgraduate-Scholar Sponsor

STUDENTS

Henry Gerung, PhD (2000 – 2006)
Qiming Li, PhD (2000 – 2005)
Madhava Kosuri, M.S. (2001 – 2003)
Thomas Gamble, PhD (2002 – 2008)
Kyle J. Solis, PhD (2003 – 2007)
Darin Leonhardt, PhD (2005 – present)
Youn-Jin Oh, visiting PhD student (2005 – 2008)
Louis Tribby, PhD (2005 – present)
Josephine Sheng, PhD (2006 – present)

TOTAL NUMBER OF STUDENTS ADVISED: 7 PhDs

Awards

School of Engineering Junior Faculty Research Excellence Award (2005)
National Science Foundation CAREER Award (2001)
The Electrochemical Society Norman Hackerman Young Author Award (1998)
National Science Foundation Summer Institute in Korea (1996)
National Science Foundation Summer Institute in Japan (1996)

Ronald E. Loehman
Department of Chemical and Nuclear Engineering
University of New Mexico
Advanced Materials Laboratory
1001 University Blvd., SE
Albuquerque, NM 87106

Ronald E. Loehman is a National Laboratories Professor at the University of New Mexico. He recently retired as a Senior Scientist from Sandia National Laboratories**.** His research specialty is high temperature behavior of inorganic solids, with an emphasis on ceramic, glass, and metal reactions. Recent projects include research on solid oxide fuel cells and processing of ultra high temperature ceramics for thermal protection systems. He is known for his work on ceramic joining and ceramic-metal composites. He also has published extensively on preparation and properties of nitrogen ceramics and glasses, crystallization of glasses, and electrical and thermal behavior of ceramics and glasses.

Professional Experience: Dr. Loehman has been on the University of New Mexico faculty since 1992. He was at Sandia from 1982 until his retirement in July 2008. At Sandia, Dr. Loehman was a Senior Scientist from 1995 -2008. Previously he was Supervisor of the Electronic Ceramics Division and Manager of the Ceramics Department. He was one of the founders of the Sandia-UNM Advanced Materials Laboratory. Before joining Sandia he was at SRI International in Menlo Park, CA and before that he was an Associate Professor at the University of Florida.

Academic Background:
B.A. in chemistry, Rice University (1964)
Ph.D. in solid state chemistry, Purdue University (1969)

Professional Associations, Honors, and Lectureships:
Fellow and past member of the Board of Directors, American Ceramic Society
Associate Editor, Journal of the American Ceramic Society (1988- 2005)
American Association for the Advancement of Science
Phi Lambda Upsilon
Sigma Xi
Keramos
National Institute of Ceramic Engineers
Visiting Scientist - University of Rennes, France
Visiting Scientist - National Defense Academy, Japan
Roland B. Snow Award American Ceramic Society
Fulrath Award American Ceramic Society
NRC Advisory Committee on Microgravity Research (1992-1997)
Listed in American Men and Women in Science, Who's Who in America, Who's Who in the West

Publications: Dr. Loehman has published more than 120 papers in scientific and technical journals. He has edited or co-edited five books

.• M. Brochu, B.D. Gauntt, R. Shah and R.E. Loehman, " Comparison between micrometer and nano glass composites for sealing SOFCs", J. Amer. Ceramic Soc. **89**[3] 810-816 (2006)

• M. Brochu, B.D. Gauntt, R. Shah, G. Miyake, R.E. Loehman, "Comparison between barium and strontium-glass composites for sealing SOFCs", J. European Ceramic Society, 26 3307-3313 (2006)

• M. Brochu, B.D. Gauntt, T. Zimmerly, A. Ayala and R.E. Loehman "Fabrication of UHTCs by conversion of dynamically consolidated Zr+B and Hf+B powder mixtures", submitted to J. Amer. Ceramic Soc. (2007)

• E. Corral, A. Ayala, and R. Loehman, "High Temperature Testing Methods for Ultra-High Temperature Ceramic Coatings on Carbon-Carbon Composites," Proceedings of the 30th International Conference on Advanced Ceramics and Composites, General Editors, Andrew Wereszczak and Edgar Lara-Curzio, Daytona Beach, FL, January 21-26, 2007

• E. Corral, B. Gauntt, and R. Loehman, "Controlling Seal Material Properties for Reliable Seal Performance Using Glass-Ceramic Composites," Proceedings of the 30th International Conference on Advanced Ceramics and Composites, General Editors, Andrew Wereszczak and Edgar Lara-Curzio, Daytona Beach, FL, January 21-26, 2007 (invited).

• M. Brochu and R.E. Loehman, "Hermetic Sealing of Solid Oxide Fuel Cells", in book to appear in 2008

• E. Corral and R. Loehman, "Ultra-High Temperature Ceramic Coatings on Carbon-Carbon Composites," *Journal of the American Ceramic Society*, accepted for publication (December 2007).

• E. Corral and R.E. Loehman, "Silicon Carbide and Zirconium Diboride Coatings for Oxidation Protection of Carbon-Carbon Composites," Proceedings of the Joint Army Navy NASA Air Force (JANNAF) on TPS and Hot Structures for Hypersonic Applications, 32nd Annual Conference on Composites, Materials and Structures, Daytona Beach FL, January 28-31, 2008.

Students and Postdoctoral fellows advised:

Dr. Loehman has served as research advisor and mentor for a number of undergraduate, graduate, and post doctoral researchers over the past fifteen years: more than 25 undergraduate research students; twelve MS theses directed through UNM, several more as co-advisor through other universities; five post doctoral fellows advised.

BIOGRAPHICAL SKETCH -GABRIEL P. LOPEZ

EDUCATION

University of Colorado, Boulder, CO, Chemical Engineering, B.S., 1985
University of Washington, Seattle, WA, Chemical Engineering, Ph.D., 1991
Harvard University, Cambridge, MA, Chemistry, Postdoctoral Fellow, 1991-1993

PROFESSIONAL EXPERIENCE

Professor of Chemical Engineering and Chemistry University of New Mexico, July 2004-present
Director, Center for Biomedical Engineering, University of New Mexico, July 2005-present
Regents' Lecturer, University of New Mexico, 1997-Present.
Associate Professor; Department of Chemical & Nuclear Engineering and Department of Chemistry; University of New Mexico, NM (1999 – 2004).
Assistant Professor, Department of Chemical & Nuclear Engineering and Department of Chemistry; University of New Mexico, NM (1993-1999).

HONORS

2008 Lecturer, 2nd Gordon Conference on Biointerface Science
2008 Chair, AVS Biomaterials Interfaces Division
2008 Scientific Advisory Board, World Biomaterials Congress
2007 Program Chair, AVS Biomaterials Interfaces Division
2006- External Advisory Board, Harvard University MRSEC
2006- Editorial Board, *Langmuir*
2006- STC.UNM Board of Directors
2005- Editorial Board, *Biointerphases*
2005-09 NIH Study Section on *Biomaterials and Biointerfaces*
2006 Named *One of the 100 Most Important Hispanics in Technology & Business*
2006- Member UNM Cancer Center
2005 HENAAC *Role Model of the Week*

CONTRACT AND GRANT SUPPORT

Currently a PI or Co-PI on 10 Contract or Grant supported projects
In the last 5 years have been a PI or Co-I on 24 Contract or Grant supported projects

PUBLICATIONS AND PATENTS

REFEREED JOURNAL ARTICLES 2008& 2009
(142 TOTAL, 69 OVER THE LAST 5 YEARS)

"Rapid Detection of Anti-Chromatin Autoantibodies in Human Serum Using a Portable Electrochemical Biosensor," Konstantinov, K.N.; Sitdikov, R.A.; Lopez, G.P., Atanassov, P.B.; Rubin, R.L. *Biosens. Bioelect.* 2008.

"Formation and Dynamics of Supported Phospholipid Membranes on a Nanotextured Substrate," Werner, J.H.; Montaño, G.A.; Garcia, A.L.; Zurek, N.A.; Akhadov, E.A.; Lopez, G.P.; Shreve, A.P. *Langmuir* (in press).

"Multiplex Lateral Flow Test Strips Fabricated by Two-Dimensional Shaping," Fenton, E.M.; Mascareñas, M.R.; Lopez, G.P.; Sibbett, S.S. *Appl. Mater. Interfaces* 2009, 1 (1), pp124-129.

"Conjugated Polyelectrolyte Capsules: Light-Activated Anti-Microbial "Roach Motels," Corbitt, T.S.; Sommer, J.R.; Chemburu, S.; Ogawa, K.; Ista, L.K.; Lopez, G.P.; Whitten, D.G.; Schanze, K.S. *Appl. Mater. Interfaces* **2009**, 1 (1), pp 48-52.

"Conjugated Polyelectrolyte Supported Bead Based Assays for Phospholipase A2 Activity," Chemburu, S.; Ji, E.; Casaña, Y.; Wu, Y.; Buranda, T.; Schanze, K.S.; Lopez, G.P.; Whitten, D.G. *J. Phys. Chem. B* **2008**, 112 (46), pp 14492-14499.

"Light-Induced Biocidal Action of Conjugated Polyelectrolytes Supported on Colloids," Chemburu, S.; Corbitt, T.S.; Ista, L.K.; Ji, E.; Fulghum, J.; Lopez, G.P.; Ogawa, K.; Schanze, K.S.; Whitten, D.G. *Langmuir* **2008**, *24*, 11053-62.

"DNA Transport in Hierarchically-Structured Colloidal-Nanoparticle Porous-Wall Nanochannels," Xia, D.; Gamble, T.C.; Mendoza, E.; Koch, S.; Lopez, G.P.; Brueck, S.R.J. *Nanolett.* **2008**, *8,* 1610-1618.

"Potential Distribution and Current Transport in Si/SiO2 Fluidic Nanochannels," Zhang, Y.; Gamble, T.C.; Neumann, A.; Lopez, G.P.; Brueck, S.R.J.; Petsev, D.N. *Lab Chip* **2008**, *8*, 1671-75.

"Biosensors Based on Release of Compounds upon Disruption of Lipid Bilayers Supported on Porous Microspheres," Piyasena, M.E.; Zeineldin, R.; Fenton, K.; Buranda, T.; Lopez, G.P. *Biointerphases* **2008**, *3*, 38-49.

"Detection of Membrane Biointeractions Based on Fluorescence Superquenching," Zeineldin, R.; Piyasena, M.E.; Sklar, L.A.; Whitten, D.; Lopez, G.P. *Langmuir* **2008**, *24*, 4125-31.

CHAPTERS

(7 TOTAL 3 OVER LAST 5 YEARS)

"Polyelectrolyte Based Fluorescent Sensors," Ogawa, K.; Achyuthan, K.E.; Chemburu, S.; Ji, E.; Liu, Y.; Lopez, G.P.; Schanze, K.S.; Whitten, D.G. In: *Organic Semiconductors in Sensor Applications,* (in press).

"Flow Cytometry, Beads and Microchannels," Buranda, T.; Sklar, L.A.; Lopez, G.P. In: *Flow Cytometry in Biotechnology,* Sklar L. Ed., Oxford Univ. Press, 2005, 105-122.

"Patterned Anodization on Aluminum Surfaces," Yan, J.; Atanassov, P.B.; Lopez, G.P. In: *The Encyclopedia of Nanoscience and Nanotechnology,* Marcel Dekker, New York, 83-89, (2004).

PATENTS

17 Total Patents Issued, 9 Patents Issued over the last 5 years.

STUDENTS

30 Post Doctoral Fellows Advised, 3 currently; 34 Graduate Students Advised, 12 currently; 61 Undergraduates Advised, 5 currently

Dimiter N. Petsev, Ph.D. Assistant Professor

Department of Chemical and Nuclear Engineering, School of Engineering, University of New Mexico,
209 Farris Engineering Center, Albuquerque, NM 87131
E-mail: dimiter@unm.edu Tel: (505) 277 3221

EDUCATION

1987	University of Sofia, Department of Chemistry, Sofia, Bulgaria Chemical Physics and Theoretical Chemistry	**M.S.**
1996	University of Sofia, Department of Chemistry, Sofia, Bulgaria	**PhD**

EMPLOYMENT

Aug.	2005 –	to present	Assistant Professor, Department of Chemical Engineering, UNM
Nov.	2004 – Aug.	2005	Research Assistant Professor, Department of Chemical Engineering, UNM
Jan.	2003 – Nov.	2004	Research Associate, Department of Chemical Engineering, UNM
Oct.	1999 – Dec.	2002	Senior Research Associate, CMMR, UAH
June	1998 – Sept.	1999	Research Associate, CMMR, UAH
Nov.	1996 – May	1998	Postdoctoral Research Associate, Chemistry Department, Purdue University

MEMBERSHIP American Chemical Society, American Electrophoresis Society

JOURNAL PUBLICATIONS Author and co-author in 55 published and accepted publications, including 8 review articles. Five more are currently pending review or are in preparation.

Publications for the period 2005-2009

Book Chapters

1. D. N. Petsev, **Transport in Fluidic Nanochannels**, in **"Nanoscience: Colloidal and Interfacial Systems"**, V. M. Starov, Editor, (Taylor & Francis, 2009).
2. N. J. Carroll, S. Mendez J. Edwards, D. A. Weitz and D. N. Petsev, **Transport control and manipulation of fluids in micro and nanofluidic channels**, in **"Structure and Functional Properties in Colloidal Systems"**, R. Hidalgo-Alvarez, Editor (Taylor & Francis), accepted.

Journal Articles

3. Z. Yuan, A. Garcia, G. P. Lopez and D. N. Petsev, **Electrokinetic Transport and Separations in Fluidic Nanochannels**, *Electrophoresis*, **28** (2007) p. 595.
4. D. N. Petsev, G. L. Lopez, C. F. Ivory and S. S. Sibbett, **Microchip Protein Separation by Electric Field Gradient Focusing**, *Lab on Chip* **5** (2005) 587.
5. A. Garcia, P. Bisong, M. J. O'Brien, L. K. Ista, D. N. Petsev, S. R. J. Brueck and G. P. Lopez, **Electrokinetic Molecular Separation in Nanoscale Fluidic Channels**, *Lab on a Chip*, **5** (2005) 1271.
6. D. N. Petsev, **Theory of Transport in Nanofluidic Channels with Moderately Thin Electrical Double Layers. Effect of Wall Potential Modulation on Solutions of Symmetric and Asymmetric Electrolytes**, *J. Chem. Phys.*, **123** (2005) 244907.
7. M. E. Piyasena, G. P. Lopez and D. N. Petsev, **An Electrokinetic Cell Model for Analysis and Optimization of Electroosmotic Microfluidic Pumps**, *Sensors and Actuators B*, **113** (2006) 461.
8. D. N. Petsev and G. P. Lopez, **Electrostatic Potential and Electroosmotic Flow in a Cylindrical Capillary Filled with Symmetric Electrolyte: Analytic Solutions in Thin Double Layer**

Approximation, *J. Colloid Interface Sci.*, **294** (2006) p. 492.

9. S. T. Chang, V. N. Paunov, D. N. Petsev and O. D. Velev, **"Self-Propelling Microdevices and Microfluidic Pumps Based on Remoutely Powered Miniature Semiconductor Diodes**, *Nature Materials*, **6** (2007) p. 235.

10. Z. Yuan, D. N. Petsev, B. G. Prevo, O. D. Velev and P. Atanassov, **Two-Dimensional Nanoparticle Arrays Derived from Ferritin Monolayers,** *Langmuir*, **23** (2007) p. 5498.

11. S. T. Chang, E. M. Beaumont, D. N. Petsev and O. D. Velev, **Remotely Powered Distributed Microfluidic Pumps and Mixers Based on Miniature Diodes**, *Lab-on-a-Chip*, **8** (2008) p. 117.

12. Y.-J. Oh, T. C. Gamble, A. Garcia, D. Leonhardt, C.-H. Chung, S. R. J. Brueck, C. F. Ivory, G. P. Lopez, D. N. Petsev, and Sang M. Han, **FET Flow Control and Wall Adsorption of Charged Molecules in Nanofluidic Channels Integrated into a Multiple Internal Reflection Infrared Waveguide**, *Lab-on-a-Chip*, **8** (2008) p. 251.

13. N. J. Carroll, S. B. Rathod, E. Derbins, S. Mendez, D. A. Weitz and D. N. Petsev, **Droplet Based Microfluidics for Emulsion and Solvent Evaporation Synthesis of Monodisperse Mesoporous Silica Microspheres**, *Langmuir*, **28** (2008) p. 658.

14. Y. Zhang, T. C. Gamble, A. Neumann, G. P. Lopez, S. R. J. Brueck and D. N. Petsev, **Potential Distribution and Current Transport in Si/SiO_2 Fluidic Channels**, *Lab-on-a-Chip*, **8** (2008) p. 1671.

15. Y.-Jin Oh, A. L. Garcia, D. N. Petsev, S. R. J. Brueck, C. F. Ivory, and S. M. Han, **Effect of Wall-Molecule Interactions on Electrokinetic Transport of Charged Molecules in Nanofluidic Channels during FET Flow Control**, *Lab-on-a-Chip*, accepted.

Presentations for the period 2005-2009: Five invited and 15 contributed

Patents:

1. ***Fabrication and Use of Semipermeable Membranes and Gels for the Control of Electrolysis,*** U.S. Patent no. 7,402,229 issued July 22, 2008 by: Scott Sibbett and Dimiter N. Petsev
2. ***Electrokinetic Molecular Separation in Nanoscale Fluidic Channels,*** U.S. Patent No. 7,465,381 issued December 16, 2008 by: P. Bisong; S. Brueck; A. Garcia; L. Ista; G. Lopez; M. O'Brien; D. Petsev**.**

Synergistic Activities:

Serving as book editor for *Emulsions: Structure Stability and Interaction, Elsevier, 2004*.

- Editorial Board Member: *Sensors & Transducers Journal, Open Journal of Physical Chemistry, Open Journal of Colloid Science*
- Serving as regular peer-reviewer for Langmuir, Journal of Colloid and Interface Science, Journal of Crystal Growth, Chemical Engineering Communications, Proceedings A of the Royal Society and Materials Research Society Proceedings, Analytical Chemistry, Electrophoresis, and for funding institutions: NSF, PRF, Israel Science Foundation.

Internal Collaborations: G. P. Lopez, P. B. Atanassov, S. Han, S. R. J. Brueck, C. J. Brinker, J. Edwards
External Collaborations: D. A Weitz (Harvard), O. D. Velev (NCSU), S. Cramer (RPI), T. S. Horozov (Hull University, UK), J. Petkov (Unilever, UK), F. van Swol (SNL)
Current Graduate Students: N. Carroll and P. Maksymiuk
Undergraduate Students: A. Ortiz and K. Hawthorne
Postdoc: J. Toro Mendoza
Students Graduated: Z. Yuan (PhD)
Past Postdocs: Y. Zhang and S. Mendez

Timothy L. Ward

Chair and Professor, Department of Chemical and Nuclear Engineering
University of New Mexico; Albuquerque, NM 87131

EDUCATION

Montana State University	B.S. Chemical Engineering	June 1978
Montana State University	M.S. Chemical Engineering	March 1984
University of Washington	Ph.D. Chemical Engineering	June 1989

RESEARCH INTERESTS

Synthesis of inorganic membranes, films, and powders by aerosol deposition, chemical vapor deposition and chemical vapor infiltration; membrane reactors; chemical physics of aerosols and microparticles; sol-gel synthesis of inorganic thin films; mesoporous particle synthesis, use of evaporation-induced self assembly and controlled phase behavior in droplets to engineer sophisticated particle architectures.

APPOINTMENTS

7/08 – present	Interim Chair	
8/06 - present	Professor	Dept. of Chem. and Nuc. Eng., Univ of New Mexico
8/98 – 7/06	Associate Professor	Dept. of Chem. and Nuc. Eng., Univ of New Mexico
8/92 – 7/98	Assistant Professor	Dept. of Chem. and Nuc. Eng., Univ of New Mexico
7/89 - 7/92	Research Assistant Professor	Dept. of Chem. and Nuc. Eng., Univ of New Mexico

HONORS AND AWARDS

UNM School of Engineering Junior Teaching Excellence Award, May 1998
UNM School of Engineering Senior Teaching Excellence Award, May 2006

PROFESSIONAL LICENSURE

State of New Mexico, P.E.

PUBLICATION RECORD

Refereed Publications: 41	Invited Talks: 8
Published Proceedings: 14	Patents: 1
Presentations (Ward): 47	Presentations Total: 65

PROFESSIONAL MEMBERSHIP

American Institute of Chemical Engineers, American Chemical Society, American Association for Aerosol Research, Electrochemical Society, Materials Research Society, American Society for Engineering Education

SELECTED PUBLICATIONS

1. S. B. Rathod and T.L. Ward, Hierarchical porous and composite particle architectures based on self assembly and phase separation in droplets, J. Mater. Chem. **17** (22), 2329-2335 (2007).

2. Q. Hu, R. Kou, J. Pang, T.L. Ward, M. Cai, Z. Yang, Y. Lu, and J. Tang, Mesoporous carbon/silica nanocomposite particles through aerosol-assisted multi-component assembly, Chem. Comm., 2007, 601-603.

3. Q. Fu, G. V. Rama Rao, T. L. Ward, Y. Lu, and G. P. Lopez, Thermo-responsive transport through ordered mesoporous silica/PNIPAAm copolymer membranes and microspheres, Langmuir **23** (1), 170-174 (2007).

4. M. T. Bore, M. P. Mokhonoana, T. L. Ward, N. J. Coville and A. K. Datye**,** Synthesis and reactivity of gold nanoparticles supported on transition metal doped mesoporous silica, Microporous and Mesoporous Mater. **95**, 118-125 (2006).

5. W. Guo, A.K. Datye, and T. L. Ward, Synthesis of barium titanate powders by aerosol pyrolysis of a pechini-type precursor solution, J. Mater. Chem. **15** (4), 470-477 (2005).

6. M. T. Bore, R.F. Marzke, T.L. Ward, and A.K. Datye, Aerosol synthesized mesoporous silica containing high loading of alumina and zirconia, J. Mater. Chem. **15** (47), 5022-5028 (2005).

7. W. Guo, T.L.Ward, C. Porter, and A.K. Datye, Phase content and particle morphology of Bi-Mo-V-O powders produced by aerosol pyrolysis, Mater. Res. Bull. **40** (8), 1371-1387 (2005).

8. M. T. Bore, H. N. Pham, E. E. Switzer, T. L. Ward, A. Fukuoka, and A. K. Datye, The role of pore size and structure on the thermal stability of gold nanoparticles within mesoporous silica, J. Phys. Chem **109** (7), 2873-2880 (2005).

9. M.T. Bore, T.L. Ward, A. Fukuoka, and A.K. Datye, Synthesis of Pt nanowires inside aerosol derived spherical mesoporous silica particles, Catalysis Letters **98** (4), 167-172 (2004).

10. M.T. Bore, S.B. Rathod, T.L. Ward, A.K. Datye, Hexagonal mesostructure in powders produced by evaporation-induced self-assembly of aerosols from aqueous tetraethoxysilane solutions, Langmuir **19** (2), 256-264 (2003).

11. G.V. Rama Rao, G.P. Lopez, J. Bravo, H. Pham, A.K. Datye, H.F. Xu, T.L. Ward, Monodisperse mesoporous silica microspheres formed by evaporation-induced self assembly of surfactant templates in aerosols, Adv. Mater. **14** (18), 1301 (2002).

12. Y. Lu, H. Fan, A. Stump, T. L. Ward, T. Rieker, and C.J. Brinker, Aerosol Assisted self-assembly of mesostructured spherical nanoparticles, Nature **398**, 223-226 (1999).

Nuclear Engineering Faculty

ABBREVIATED CURRICULUM VITAE
ROBERT D. BUSCH, Ph.D, P.E.

Lecturer III
Department of Chemical and Nuclear Engineering, MSC 01-1120
The University of New Mexico, Albuquerque, New Mexico 87131

ACADEMIC BACKGROUND

1976 Ph.D., Nuclear Engineering, University of New Mexico,
1972 M.S., Nuclear Engineering, University of New Mexico,
1971 B.S., Physics, Harvey Mudd College, Claremont, Calif.

EXPERIENCE

Director Nuclear Criticality Safety Group, Lecturer III, and Director Nuclear Engineering Laboratory at the University of New Mexico; [1986 to present]. -- Teaching 4 to 6 courses each semester and supervising the nuclear engineering laboratory and AGN-201M 5-watt nuclear training reactor. Teaching reactor experiments lab for seniors on AGN-201 and graduate students on LANL machines (SHEBA, GODIVA, FLATTOP), and SNL's ACRR, heat transfer and fluid flow laboratory, and nuclear systems courses for undergraduates, the senior capstone design course in nuclear power design, and graduate courses in radioactive waste management, nuclear environmental safety analysis, and in interaction of radiation with matter.

Director, Nuclear Criticality Safety Short Course; [1989 to present]
Director, Nuclear Criticality Safety Workshop for Managers; [1994 to present.]
Director, Workshop on Applications of Double Contingency in Nuclear Criticality Safety; [1998 to present.]
Nuclear Regulatory Commission-licensed Senior Reactor Operator; [1976 to 1982 and 1985 to present]

HONORS AND PROFESSIONAL SOCIETIES

Outstanding Adjunct Teacher/Lecturer of the Year, University of New Mexico, 2004-2005.
Distinguished Service Award from the Nuclear Criticality Safety Division of the American Nuclear Society, November 2001.
Outstanding Faculty Recognition Award, UNM School of Engineering, 2000, 1997, 1995
Senior Faculty Teaching Excellence Award, UNM School of Engineering, 1997
American Nuclear Society
Member of N-16 National Standards Consensus Committee
Member of ANS-1 Standards Committee "Safety Guide for the Performance of Critical Experiments."
Chair, ANS 8.24 Working Group – Standard on the Validation and verification of Calculational Methods for Nuclear Criticality Safety
Technical Program Chair, ANS Winter Meeting, Albuquerque, NM, Nov. 2006
Presidential Citation, June 2006

REGISTRATION

Registered Mechanical Engineer, State of New Mexico, #8523
Vice Chair PE examination committee, Nuclear Engineering PE exam.

PUBLICATIONS (since 2003)

Barber, A.Miller, and R.D. Busch, "Variation of Extrapolation Distance with U-235 Concentration," in ***Transactions of 2008 Winter Meeting of the American Nuclear Society,*** Reno, NV November 9-13, 2008.

Bowen, D.G. and R.D. Busch, "**Hand Calculational Methods for Criticality Safety – A Primer**," LA-14244-M, LANL, November 2006.

Saavedra, S.F., and R.D. Busch, "Critical Mass of U-235 Systems with Varied Moderators and Reflector Materials," in ***Transactions of 2006 Winter Meeting of the American Nuclear Society,*** Albuquerque, NM November 12-16, 2006.

Busch, R.D., et al., "Tutorial on the Proposed ANSI/ANS 8.24 Standard: Validation of Neutron Transport Methods for Nuclear Criticality Safety Calculations," in ***Transactions of 2006 Annual Meeting of the American Nuclear Society,*** Reno, NV June 4-8, 2006.

Busch, R.D, and S.M. Bowman, "***KENO V.a Primer: A Primer for Criticality Calculations with SCALE/KENO V.a Using GeeWiz,***" ORNL/TM-2005/135, ORNL, December 2005.

Cox, J.W., and R.D. Busch "A Guide For The Application Of MCNP In The Analysis Of Complex Nuclear Reactors And Other Critical Assemblies," ***Topical Meeting on Nuclear Criticality Safety***, Knoxville, TN, September 2005.

Bowen, D.G., and R.D. Busch "Hand Calculational Methods for Criticality Safety – A Primer," ***Topical Meeting on Nuclear Criticality Safety***, Knoxville, TN, September 2005.

Kauffman, D., R.D. Busch, A.K. Datye, and T.L. Ward, "The Minimum Core for Chemical Engineering: How Much Bathwater Can We Throw Out?", Proceedings of the ASEE Annual Conference, Portland, OR, June 2005.

Thomson, B.M, C.L. Smith, R.D. Busch, M.D. Siegel, and C. Baldwin, "Removal of Metals and Radionuclides Using Apatite and Other Natural Sorbents," ***Journal of Environmental Engineering***, Vol. 129, Number 6, June 2003.

Busch, R.D, and S.M. Bowman, "***KENO V.a Primer: A Primer for Criticality Calculations with SCALE/KENO V.a Using CSPAN for Input,***" ORNL/TM-2002/155, ORNL, January 2003.

Contracts (from 2004 to present)

"Criticality Workshop for UK", BNFL, $50K, completed September 2008
"Critical Mass Information", US NRC, $118K, completed April 2009
"Criticality Workshop for UK", BNFL, $50K, completed September 2006
"Innovations in Nuclear Infrastructure and Education", US DOE, 5 years, $150K, ends Sept. 2010
"Reactor Instrumentation Upgrade" Dept. of Energy, $15.2K, awarded June 2005.
"Criticality Workshop for UK", BNFL, $50K, completed September 2004

RESEARCH INTERESTS

Nuclear Criticality Safety
Radiation Protection and Shielding
Characterization of Reactor Physics Parameters
Utilization of Cosmic Rays for Liquid Level Measurement in Zero-G Environments

GARY W. COOPER, Associate Professor
Department of Chemical and Nuclear Engineering, MSC 01-1120
The University of New Mexico, Albuquerque NM 87131

ACADEMIC BACKGROUND

1976	Ph.D., Nuclear Engineering	University of Illinois at Urbana-Champaign
1972	M.S., Nuclear Engineering	University of Illinois at Urbana-Champaign
1970	B.S., Engineering Physics	University of Kansas, Lawrence, Kansas

EXPERIENCE

Associate Professor, Department of Chemical and Nuclear Engineering, University of New Mexico (1988 to present)

Assistant Professor, Department of Chemical and Nuclear Engineering, University of New Mexico (1979 to1988).

PUBLICATIONS

S.A. Slutz, J.E. Bailey, G.A. Chandler, G.R. Bennett, G. Cooper, J.S. Lash, S. Lazier, P. Lake, R.W. Lemke, T.A. Mehlhorn, T.J. Nash, D.S. Nielson, J. McGurn, T.C. Moore, C.L. Ruiz, D.G. Schroen, J. Torres, W. Varnum, and R.A. Vesey, "Dynamic hohlraum driven inertial fusion capsules", **Phys. Plasmas, 10,** 1875-1882 (2003).

J.E. Bailey, G.A. Chandler, S.A. Slutz, I. Golovkin, P.W. Lake, J.J. MacFarlane, R.C. Mancini, T.J. Burri-Mog, G. Cooper, R.J. Leeper, T.A. Mehlhorn, T.C. Moore, T.J. Nash, D.S. Nielson, C.L. Ruiz, D.G. Schroen, and W.A. Varnum, "Hot dense capsule implosion cores produced by z-pinch dynamic hohlraum radiation", **Phys. Rev. Lett., 92**, 085002-1 (2004).

C.L. Ruiz, G.W. Cooper, S.A. Slutz, J.E. Bailey, G.A. Chandler, T.J. Nash, T.A. Mehlhorn, R.J. Leeper, D. Fehl, A.J. Nelson, J. Franklin, and L. Ziegler, "Production of thermonuclear neutrons from deuterium-filled capsule implosions driven by Z-pinch dynamic hohlraums", **Phys. Rev. Lett., 93,** 015001-1 (2004).

T.W.L. Sanford, T.J. Nash, R.E. Olson, D.E. Bliss, R.W. Lemke. C.L. Olsen, C.L. Ruiz, R.C. Mock, J.E. Bailey, G.A. Chandler, M.E. Cuneo, R.J. Leeper, M.K. Matzen, T.A. Mehlhorn, S.A. Slutz, W.A. Stygar, D.L. Peterson, R.E. Chrien, R.G. Watt, N.F. Roderick, G.W. Cooper, J.P. Apruzese, G.S. Sarkisov, J.P. Chittenden, and M.G. Haines, "Progress in z-pinch driven dynamic-hohlraums fro high-temperature radiation-flow and ICF experiments on Sandia National Laboratories, **Plasma Phys. Control. Fusion 46,** B423-B433 (2004).

SA Slutz, JK Peterson, RA Vesey, RW Lemke, JE Bailey, W Varnum, CL Ruiz, GW Cooper, GA Chandler, GA Rachau, and TA Mehlhorn, "Integrated two-dimensional simulations of

dynamic hohlraum driven inertial fusion capsule implosions", Physics of Plasmas, 13, 102701 (2006).

CA Coverdale, C Deeney, AL Velikovich, RW Clark, YK Chong, J Davis, J Chittenden, CL Ruiz, GW Cooper, AJ Nelson, J Franklin, PD LePell, JP Apruzese, J Levine, J Banister, and N Qi, "Neutron production and implosion characteristics of a deuterium gas-puff Z pinch", Physics of Plasmas, 14, 022706 (2007).

CA Coverdale, C Deeney, AL Velikovich, J Davis, RW Clark, YK Chong, J Chittenden, S Chantrenne, CL Ruiz, GW Cooper, AJ Nelson, J Franklin, PD LePell, JP Apruzese, J Levine, and J Banister, "Deuterium gas-puff Z pinch implosions on the Z accelerator", Physics of Plasmas **14,** 056309 (2007)

AL Velikovich, RW Clark, J Davis, YK Chong, C Deeney, CA Coverdale, CL Ruiz, GW Cooper, AJ Nelson, J Franklin, LI Rudakov, "Z-pinch plasma neutron sources", Physics of Plasmas **14**, 022701 (2007)

Professional Organizations and Service (2003-Present)

American Nuclear Society
IEEE
Reviewer for IEEE PLASMA SCIENCE

University Service (2003 to Present)

University Radiation Control Committee
University Undergraduate Committee
School of Engineering Graduate Committee
Nuclear Engineering Graduate Adviser
Tenure and Promotion Committee
Nuclear Engineering Search Committees

Classes Taught (2003 – Present)

ChNE 231 Introduction to Nuclear Engineering
ChNE 323 Radiation Detection and Measurement
ChNE 452 Senior Seminar
ChNE 485 Fusion Technology
ChNE 523 Environmental Measurements
ChNE 528 External Dosimetry

CASSIANO R. E. DE OLIVEIRA

Dept. of Chemical and Nuclear Engineering
MSC01 1120; 209 Farris Engineering Center
1 University of New Mexico
Albuquerque, NM 87111
Tel: (505) 277-5661 Fax: (505) 277-5633
E-mail: cassiano@unm.edu

I. EARNED DEGREES

Ph. D., Nuclear Engineering, Queen Mary and Westfield College, University of London (1986)
M. Sc., Nuclear Engineering, Federal University of Rio de Janeiro, Brazil (1980)
B. Sc., Physics, Catholic University of Rio de Janeiro, Brazil (1976)

II. EMPLOYMENT

2007-present	Professor, Department of Chemical and Nuclear Engineering, University of New Mexico
2003 – 2007	Professor, Nuclear and Radiological Engineering Program, G.W.W School of Mechanical Engineering, Georgia Institute of Technology
2000 -2003	Senior Lecturer, Department of Earth Science and Engineering, Imperial College London, UK
1996 -2000	Senior Research Fellow in the T H Huxley School, Imperial College of Science, Technology and Medicine, London, UK
1990 -1996	British Nuclear Fuels Research Fellow, Mechanical Engineering Department, Imperial College of Science, Technology and Medicine, London, UK
1988 -1989	Research Associate, Department of Mechanical Engineering, Queen Mary and Westfield College, London, UK
1979 – 1987	Research Officer at the Reactor Department of the Nuclear Engineering Institute, Rio de Janeiro, Brazil.

III. SCHOLARLY ACCOMPLISHMENTS

A. REFEREED PUBLICATIONS

61 peer-reviewed journal publications and 56 peer-reviewed conference proceedings in the fields of computational radiation transport, nuclear engineering, computational fluid dynamics, high-performance computing and computational mathematics.

B. OTHER SCHOLARLY ACCOMPLISHMENTS

- Developed general purpose the neutral particle radiation transport code EVENT. The code is in use by Rolls Royce Marine Power for naval reactor shielding, and by Imperial College London, Technical University Delft and Idaho National Laboratory
- Co-developed nuclear criticality assessment code FETCH. The code is used by IRSN, France and JAERI, Japan.
- INL-UNM Joint Appointee (2008-present)

IV. SERVICE

A. PROFESSIONAL CONTRIBUTIONS

- *Professional Society Membership*
  - Vice-Chair of Georgia ANS Chapter (2005-2006)
  - Member, Executive Committee of the Mathematics and Computation Division of the American Nuclear Society (2002-2005)
  - Member, American Nuclear Society (1997-present)
- *Committee memberships*
  - Member, Working Party Nuclear Criticality Accidents, NEA/OECD, Paris. (2005present)
  - Member, Executive Board of the Frederic Joliot and Otto Hahn Summer School on Nuclear Reactors (2003-2006)

- Chairman, Working Party on Nuclear Criticality Accidents, NEA/OECD, Paris. (20012003)
- Member, United Kingdom Nirex Post-Closure Criticality Assessment Committee (20012003)

- *Conference organization*
  - Organizer of the 17th International Transport Theory Conference, July 1-7, 2001, Imperial College, London, with 73 papers and 80 participants.
- *Journal editing and reviewing*
  - Member, Editorial Board of Annals of Nuclear Energy and Journal of Geophysics and Engineering
  - Reviewer for *Annals of Nuclear Energy*, *Nuclear Science and Engineering*, *Nuclear Technology*, *Transport Theory and Statistical Physics*, *International Journal of Numerical Methods in Fluids*, *International Journal of Heat Transfer*, *Journal of Nuclear Science and Technology*, *Journal of Hybrid Methods*, *Vacuum*, *Journal of Computational Physics*, *Medical Physics*, *Applied Optics*, *Optics Express*

B. OTHER CONTRIBUTIONS

- Consultant to the OECD Nuclear Energy Agency**,** UK Ministry of Defense, British Energy, NIREX, Rolls Royce Marine Power, British Nuclear Fuels, Electrowatt, Edwards High Vacuum

VI. RECENT GRANTS AND CONTRACTS

- DTRA Award DTRA01-03-D-0009-001 "Combined Application of Deterministic and Stochastic Transport Methods to Multi-Particle Interrogation Source Validation and Optimization", Oct 2008-Sep 2009, $300,000
- DOE NEER Grant DE-FG07-04ID14604 "Hierarchical Adaptive Solution of the Radiation Transport Problems on Unstructured Grids", Aug 2004-Jul 2007, $297,923
- DOE Idaho National Laboratory LDRD Grant, "A Unified Multi-Physics Algorithm for High-Resolution Analysis of Generation IV Gas-Cooled Reactor Systems", April 2005 September 2007, $250,000.
- DOE Oak Ridge National Laboratory LDRD Grant, "Terascale Simulation Tools for Next-Generation Nuclear energy Systems", Oct 2005 – Sep 2007, $100,000.

VII. RECENT RELEVANT PUBLICATIONS

- J.L.M.A. Gomes, C.C. Pain, M.D. Eaton, A.J.H. Goddard, M.D. Piggott, A.K. Ziver, C.R.E. de Oliveira , Y. Yamane, "Investigation of nuclear criticality within a powder using coupled neutronics and thermofluids", Annals of Nuclear Energy, (2009)
- Sacco, W. F., Filho, H. A., Henderson, Nelio and de Oliveira, C. R. E., "A Metropolis Algorithm Combined with Nelder-Mead Simplex Applied to Nuclear Core Design, Annals of Nuclear Energy, **35** (2008) 861-867
- Ibarra, L., Lockwood, B. and de Oliveira, C. R. E., "A One-and Two-Dimensional PCICE-Based Multiphysics Algorithm for Use in Reactor Core Calculations", (Proceedings of the Joint International Topical Meeting on Mathematics & Computation and Supercomputing in Nuclear Applications, M&C 2007+SNA 2007, Monterey, USA, April 15-19, 2007).
- Ziver, A. K., Pain, C. C., Carter, J. N., de Oliveira, C. R. E., Goddard, A. J. H. and Overton, R. S. "Genetic Algorithms and Artificial Neural Networks for Loading Pattern Optimisation of Advanced Gas-Cooled Reactors", Annals of Nuclear Energy, **31** (2004) 431-457.
- Pain, C. C., Herwanger, J. V., Saunders, J. H., Worthington, M. H. and de Oliveira, C. R. E., "Anisotropic Resistivity Inversion", Inverse Problems, **19** (2003) 1081-1111.

Curriculum Vitae – Mohamed S. El-Genk
MSC01 1120, *1 University of New Mexico, Albuquerque, NM, 87131, (505) 277-5442, FAX: (505) 277-2814, and Email*:
mgenk@unm.edu; http://www.unm.edu/~ISNPS/personnel/el-genk.html

Professional Preparation

Ph.D., Nuclear Engineering, University of New Mexico (1978)
M.S., Nuclear Engineering, University of Alexandria, Egypt (1975)
BS, Nuclear Engineering, University of Alexandria, Egypt (1968)

Appointments

- Regents' Professor, Chemical & Nuclear Engineering (1996 – present) Mechanical Engineering and (2006 - present), UNM
- Professor (1988-96) Chemical and Nuclear Engineering, UNM
- Associate Professor (1984-88) Chemical and Nuclear Engineering, UNM
- Assistant Professor (1981-84) Chemical and Nuclear Engineering, UNM
- Founding Director (1984-present) Institute for Space and Nuclear Power Studies, UNM
- Interim Associate Chair (1996-97) Chemical and Nuclear Engineering Department, UNM
- Nuclear Engineering Graduate Advisor (1989-96) Nuclear Engineering, UNM
- Engineering Specialist (1980-81); Associate Engineering Specialist (1978-80), Light Water Reactor (LWR) Fuel Behavior Research Division, EG&G Idaho, Idaho Falls, ID
- Research Engineer (1974-75) Egyptian Atomic Energy Commission, Egypt.
- Power Engineer (1968-74) Egyptian General Organization of Industrialization, Egypt.

Research Interest: Pool boiling, two-phase flow, single phase natural and mixed convection; vapor explosion; severe reactor accident analyses; reactor design, neutronics, safety and thermal-hydraulics of nuclear reactors; nuclear fuel and materials; nuclear fuel cycle; multi-physics modeling and simulation; transport and interfacial phenomena; high temperature reactors; Closed Brayton Cycle (CBC) energy conversion and gas turbo-machinery; static energy conversion (TE, TI, and AMTEC); thermal management of space systems; space nuclear power and propulsion; heat pipes and thermosyphons; advanced cooling using impinging and swirling jets and submersion pool boiling on micro-porous and nano-dendrites metal surfaces; and flow in micro-channels.

Academic Record: Refereed Papers 265 Conference Proceedings Full Papers 237 Conference Transactions Articles / Technical Reports 57 / 72 Book Chapters / patents 4 / 4 (2 pending) Ph.D. Dissertations supervised (1981- 08) *26* (5 in progress) M.S.. Theses supervised (1981- 08) *26* (1 in progress)

Patents

- U. S. Patent No. 5,106,574, *Nuclear Reactor Refuelable in Space*, 1992
- U. S. Patent No. 5,428,653, *Apparatus and Method for Nuclear Power and Propulsion*,1995
- U. S. Patent No.5, 747,418, *Superconducting Thermoelectric Generator*, 1998
- US Patent No. 11/467,745, Methods for Processing Multifunctional, Radiation Tolerant Nanotube-Polymer Structural Composites*, with M. Al-Haik,* 2007
- UNM Patent Application No. UNM– 804, Processing of Magnetically Aligned Carbon Nanotubes Photovoltaic Cell, with M. Al-Haik and C. Fledderman, Pending, May 2006.
- UNM Patent Application No. UNM-827, Hybrid Heat Pipes/Thermosyphon Heat Exchanger for Very High Temperature Nuclear Reactor (VHTR) Plants, with Jean-Michel Tournier, pending May 2007

Recognitions

El-Genk was named in 2001 the *46th Annual Research Lecturer*, the highest honor bestowed upon a member of the faculty. He was named Regents' Professor of Chemical and Nuclear Engineering in 1996 and of Mechanical Engineering in 2006. In 1984-85 he received the Presidential Lectureship Award and in 1987-88 was the recipient of the Graduate Students' Outstanding Teacher Award. He received the SOE Research Excellence Award in 1988 and the Teaching Excellence Award in 1989. In 1996, he received the Student's Faculty Recognition Award. He is Fellow of ANS, ASME, AIChE, and International Association for the Advancement of Space Safety (IAASS), and an Associate Fellow of AIAA.

El-Genk was the recipient of ANS Distinguished Faculty Member Honor in 1987 and AIChE Heat Transfer and Energy Conversion Division Award in 2000. He was a member of *NASA Space Exploration of the Solar System Technology Assessment Group* in 2001 – 2002 and *NASA Advanced Radioisotope System (ARPS) Team – 2001 Technology Assessment and Recommended Roadmap for Potential NASA Code S Missions Beyond 2011*, in 2000 – 2001. In 1992, El-Genk received *United States Department of Energy's Certificate of Appreciation for his Outstanding Contribution to the field of Space Nuclear Power and Propulsion*. He served as member of and chaired ASME/AIChE Board of Max Jacob Memorial Award for outstanding advances in heat transfer (1997 – 2000 and 2003 – 2007), the AIChE Committee of Donald Q. Kern Award for advances in practical applications of heat and mass transfer (1998 – 1999 and 2004 – 2006), ASME/AIChE National Heat Transfer Conference Coordinating Committee (1997 – 2001) and Executive Committee of AIChE Heat Transfer and Energy Conversion Division (2001 – 2003).

El-Genk chaired the Executive Committee of AIChE Transport and Energy Processes Division in 2003, served on the organizing committees of many technical conferences, organized and chaired numerous technical sessions, and has been invited as keynote and plenary speaker at many technical conferences. He has been the organizer and technical and publication chair of annual meeting: *Space Technology and Applications International Forum (STAIF),* 1993 – 2008*,* and *Symposium on Space Nuclear Power and Propulsion*, 1984 – 1992*.*

El-Genk has been a member of Scientific Committee of 13th International Conference on Emerging Nuclear Energy Systems (ICENES 2007) and the Program Committee of 3rd Conference of International Association for Advancement of Space Safety (IAASS) in 2008. He is member of the Scientific Committee of ICENES 2009; International Scientific Advisory Committee of 2nd International Conference on Energy and Sustainability 2009 (Energy-2009*)*; Scientific Council of International Center for Heat and Mass Transfer; Editorial Board of Journal of Energy Conversion and Management; International Assembly of International Heat Transfer Conference, and the IAASS Academic Committee. El-Genk is a life member of Phi Kappa Phi National Honor Society and Area Editor of Int. Journal of Process Systems Engineering (IJPSE).

Representative Publications:

1. El-Genk, M. and H. Saber, "Thermal and Performance Analyses of Efficient Radioisotope Power Systems," J. Energy Conversion and Management, 47, 2290 – 2307, 2006
2. Parker, J. L. and M. S. El-Genk, "Effect of Surface Orientation on Nucleate Boiling of FC-72 on Porous Graphite," J. Heat Transfer, 128, 1159 – 1175, 2006
3. El-Genk, M. S., and Jean-Michel Tournier, "Noble Gas Binary Mixtures for CBC Space Reactor Power Systems," *J. Propulsion and Power,* 23 (4), 863 – 873, 2007
4. King, J. C. and M. S. El-Genk, "Temperature and Burnup Reactivities and Operational Lifetime for the Submersion Subcritical Safe Space (S^4) Reactor," J. Nucl. Eng. and Design, 237, 552 – 564, 2007
5. Tournier, J.-M., and M. S. El-Genk, "Properties of Helium, Nitrogen, and He-N_2 Binary Gas Mixtures," *J. Thermophysics and Heat Transfer,* 22(3), 442 – 456, 2008.
6. El-Genk, M. S., "Space Reactor Power Systems with No Single Point Failures," *J. Nuclear Engineering and Design*, 238, 2245 – 2255, 2008
7. El-Genk, M. S. and In-Hwan Yang, "Friction Numbers and Viscous Dissipation Heating for Laminar Flows of Water in Micro-tubes," J. Heat Transfer, 130(8), 2008
8. Hatton, S. H. and M. S. El-Genk, "Sectored Compact Space Reactor (SCoRe) Concepts with a Supplementary Lunar Regolith Reflector," Progress in Nuclear Energy, 51, 93-108, 2009
9. El-Genk, M. S. and Jean-Michel Tournier, "Performance Analyses of VHTR Plants with Direct and Indirect Closed Brayton Cycles," J. Progress in Nuclear Energy, 51, 556 – 572, 2009
10. Schriener, T. M. and M. S. El-Genk, "Reactivity Control Options for Space Nuclear Reactors," J. Progress in Nuclear Energy, 51, 526 – 542, 2009

Curriculum Vitae
Adam A. Hecht, Ph.D.

231 Farris Engineering Center Department of Chemical and Nuclear Engineering University of New Mexico Albuquerque, NM 87131-0001 hecht@unm.edu
(505) 277-1654

Education

Ph.D. Yale University Physics, 2004
M.Phil. Yale University Physics, 2001
M.S. Yale University Physics, 1999
B.S. University of California, Irvine Physics, 1997

Research summary

Research experience is in experimental nuclear physics, with an emphasis on gamma-ray radiation detection and measurement. Laboratory work includes building up detector array systems and signal electronics; designing, building and repairing ion chambers and scintillation systems for charged particle detection and characterization; and programming data acquisition and controls systems. Calculation experience includes deterministic and Monte Carlo modeling.

Research experience

Assistant Professor in the Department of Chemical and Nuclear Engineering, University of New Mexico, August 2008 to present. Emphasis of work is experimental radiation detection and radiation beam work, with strong modeling skills. Applications include novel accelerator techniques, radiotherapy treatment in medical physics, and source detection and interrogation for nuclear safeguards.

- Plans to study nanocrystal scintillator response to indirectly ionizing radiation
- Developing filtering techniques for detecting and characterizing low radiation signal with high background applicable to nuclear safeguards.
- Experimental work on active actinide interrogation techniques.
- Continuing with modeling beam interactions, and neutron production, in proton beam, alpha-particle beam, and heavy-ion beam radiotherapy using Geant4 based Monte Carlo code I developed.

Post-Doctoral Fellow in the Department of Medical Physics, University of Wisconsin at Madison, July 2007 to July 2008.

- Experiment and calculation work on radiation therapy beam interactions with matter.
- Experimental work to measure secondary neutron production from proton beams to characterize proton-beam radiation therapy, using proportional gas counters.
- Modeled neutron production in proton-beam, alpha-beam, and heavy ion beam reactions using Geant4 based Monte Carlo code I developed
- Coauthor on pending patent for novel accelerator techniques.

Research Associate at Argonne National Laboratory, Physics Division, through the University of Maryland, February 2004 to June 2007.

- Gamma-ray spectroscopy and mass measurements of very neutron-rich or proton-rich nuclei important to the stellar nucleosynthesis processes which produce the elements.

Instrument design and development:

- Designed and built β–γ detector array and the beam optics used to couple the Canadian Penning trap system at Argonne to a moving implantation tape.

Proton-rich "rp-process" nucleosynthesis:

- Led collaboration using the Gammasphere *Ge* detector array at Argonne for gamma-ray spectroscopy, and participated with other labs, to study "superallowed" alpha decay near ^{100}*Sn* and termination of the rp-process. Used particle tagging in γ-spectroscopy.
- Led collaboration using the Canadian Penning trap for precise mass measurements of proton-rich nuclei near ^{100}*Sn*.

Other:

- Led investigation of the few eV (near optical!) nuclear transition in ^{229}*Th* at the Advanced Photon Source synchrotron radiation ring at Argonne.

Doctoral Research in low energy accelerator nuclear physics, Wright Nuclear Structure Laboratory, Yale University, 1997 to 2004.
Dissertation: Experiments on Chiral Symmetry Breaking in the Mass A ~ 130 Region.

- Dissertation research leading and collaborating in gamma-ray spectroscopy experiments to investigate excited nuclear states. Discovered several new high spin bands in *Pm* and *Eu* nuclei and found structure consistent with predictions. Published several papers on the results.
- Coded the control program and built various mechanisms as needed for the detector array nitrogen cooling systems.
- Assisted in a variety of other experiments in electronics set-up, including building ion chambers used for charged particle identification.

5 selected publications on experimental γ-ray detection and spectroscopy using particle tagging

Structure of neutron rich Zn isotopes A.A. Hecht, W. B. Walters, N. Hoteling, M.P. Carpenter, R.V.F. Janssens, T. Lauritsen, D. Seweryniak, X. Wang, S. Zhu, B. Fornal, R. Broda, W. Krolas, J.Wrzesinski, A. Woehr, J. Stone, N.J. Stone. Submitted Phys. Rev. **C**

Single-Neutron States in ^{101}Sn D. Seweryniak, M. P. Carpenter, S. Gros, A. A. Hecht, N. Hoteling, R. V. F. Janssens, T. L. Khoo, T. Lauritsen, C. J. Lister, G. Lotay, D. Peterson, A. P. Robinson, W. B. Walters, X. Wang, P. J. Woods, S. Zhu. Phys. Rev. Lett. **99**, 022504 (2007)

Alpha decay of ^{105}Te D. Seweryniak, K. Starosta, C.N. Davids, S. Gros, A.A. Hecht, N. Hoteling, T.L. Khoo, G. Lotay, D. Peterson, A. Robinson, K. Vaman, W.B. Walters, P.J. Woods, S. Zhu. Phys. Rev. **C 73**, 061301 (2006).

Discovery of ^{109}Xe and ^{105}Te: Superallowed Alpha Decay near Doubly Magic ^{100}Sn S.N. Liddick, R. Grzywacz, C. Mazzocchi, R.D. Page, K.P. Rykaczewski, J.C. Batchelder, C.R. Bingham, I.G. Darby, G. Drafta, C. Goodin, C.J. Gross, J.H. Hamilton, A.A. Hecht, J.K. Hwang, S. Ilyushkin, D.T. Joss, A. Korgul, W. Królas, K. Lagergren, K. Li, M.N. Tantawy, J. Thomson, J.A. Winger. Phys. Rev. Lett. **97**, 082501 (2006).

Search for Enhanced Alpha Preformation in the N = Z+1 Nuclei ^{113}Ba, ^{109}Xe, ^{105}Te A.A. Hecht, C.J. Lister, C.N. Davids, A. Heinz, N. Hoteling, C. Mazzocchi, J. Palombo, D. Seweryniak, J. Shergur, M. Stoyer, W.B. Walters, P.J. Woods, and S. Zhu. AIP. Conf. Proc. **819**, (2006).

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Education

1976 B.Sc. (*1st Class Honors*) Nuclear Engineering, Queen Mary Coll., University of London, UK.
1980 Ph.D. Nuclear Engineering, Queen Mary College, University of London, UK.

Professional Experience

2006- ***Associate Director***, Center for Nuclear Nonproliferation Science and Technology, UNM.
2002- ***Associate Chair***, Chemical and Nuclear Engineering Department, UNM.
1995- ***Professor*** of Chemical and Nuclear Engineering, UNM.
1999- ***Secondary Appointment: Professor***, Mathematics and Statistics Department, UNM
1989-95 ***Associate Professor*** of Chemical and Nuclear Engineering, UNM.
1987-89 ***Assistant Professor*** of Chemical and Nuclear Engineering, UNM.
1980-87 ***Research Engineer,*** Mechanical, Aerospace and Nuclear Engineering Department, UCLA.

1994 ***Visiting Professor,*** Mechanical, Aerospace and Nuclear Engineering Department, UCLA.
1993 ***Visiting Professor***, Dept. of Reactor Physics, Chalmers University, Goteborg, Sweden

Recent Honors

2003 Fellow of the American Nuclear Society
2003 UNM School of Engineering "Senior Faculty Teaching Excellence Award"

Professional Activities (selected)

1995-2005 Associate Editor, ***Annals of Nuclear Energy***

2005- present Member of the Editorial Board, ***Annals of Nuclear Energy***

1996- present Member of the Editorial Board, ***Transport Theory and Statistical Physics***

American Nuclear Society:

Fellow; Member of Executive Committee, Mathematics and Computations Division 1998-2001, 2007-2010; Chair, Program Committee, Mathematics and Computations Division 2002-04; member of Technical Program Committees for Mathematics and Computations Division Topical Meetings over many years; Special Session organizer on deterministic and stochastic transport methods for numerous Mathematics and Computations Division meetings.

Member, *Society of Industrial and Applied Mathematics*

Technical Expertise

Professor Prinja has over 20 years of research experience in theoretical and computational modeling of neutral and charged particle transport in deterministic and random media. He has developed stochastic spectral methods for uncertainty quantification in radiation transport and closure methods for radiation transport in clumpy mixtures as well as in turbulent media. Professor Prinja has extensive experience in developing discontinuous finite element discretizations for neutral and charged particle transport, and has also investigated convergence acceleration schemes using asymptotic analysis. Professor Prinja has given

numerous seminars and invited talks on these and related topics at national and international conferences and at US and European universities.

Selected Publications

E.W. Larsen and A.K. Prinja, "A New Derivation of Akcasu's MLP Equations for 1-D Particle Transport in Stochastic Media," *Annals of Nuclear Energy*, **35,** 620 (2008).

E.D. Fichtl, A.K. Prinja, and J.S. Warsa, "Stochastic Methods for Uncertainty Quantification in Radiation Transport," To appear in *Proceedings of 2009 International Conference on Advances in Mathematics, Computational Methods and Reactor Physics*, May 3 – 7, 2009, Saratoga Springs, NY

J. E. Morel, A.K. Prinja, J.M. McGhee, T.A. Wareing, and B.C. Franke, "A Discretization Scheme for the Three-Dimensional Angular Fokker-Planck Operator," *Nuclear Science and Engineering.* **156,** 154 (2007).

A.K. Prinja and E.D. Fichtl, "Stochastic Averaging of Cross Section Uncertainty in Radiation Transport," *Proceedings of the International Conference on Mathematics and Computation+Supercomputing in Nuclear Applications,* April 15 - 19, 2007, Monterey, CA

A.K Prinja and E.D. Fichtl, "Atomic Mix Synthetic Acceleration of Dose Computations in Binary Statistical Media," *Nucl. Sci. Eng.*, **155**, 441-448 (2007).

E.D. Fichtl, J.W. Warsa, and A.K. Prinja,, "Krylov Acceleration for Transport in Binary Statistical Media," *Trans. Amer. Nucl. Soc.* **95**, 556 (2006).

A.K. Prinja and B.C. Franke, "A Regularized Boltzmann Collision Operator for Highly Forward Peaked Scattering," in Computational Methods in Transport, F. Graziani (Ed.), *Lecture Notes in Computational Science and Engineering*, **48,** Springer Verlag (2006).

B.C. Franke and A.K. Prinja, "Monte Carlo Electron Dose Calculations Using Discrete Scattering Angles and Discrete Energy Losses," *Nuclear Science and Engineering.* **149**,1 (2005).

A.K. Prinja and G.L. Olson, "Grey Radiative Transfer in Binary Statistical Media with Material Temperature Coupling: Asymptotic Limits," *J. Quant. Spect. and Rad. Transfer*, **90**, 131, (2005).

A.K. Prinja, "On the Master Equation Approach to Transport in Discrete Random Media in the Presence of Scattering," *Annals of Nucl. Energy* **31**, 2005 (2004).

Curriculum Vitae of **Taro Ueki** as of February 2009

Title: Assistant Professor, Chemical and Nuclear Engineering, The University of New Mexico **Start of Appointment**: August 2003 **Contact information:** 209 Farris Engineering Center**,** Albuquerque, NM 87131

Voice: 505-277-7964, Fax: 505-277-5433, Email: tueki@unm.edu

Education

September 1992 - April 1998: The University of Michigan, Nuclear Engineering and Radiological Sciences; Ph.D., August 1998; M.S., August 1994.

April 1983 - March 1987: Nagoya University, Japan; Nuclear Engineering; B.S., March 1987.

Previous Professional Experience

September 2001 -August 2003: Postdoctoral Associate at Diagnostics Applications Group (X-5) at Los Alamos National Laboratory.

June 1998 - June 2000: Postdoctoral Scientist at Interfaculty Reactor Institute at Delft University of Technology in The Netherlands.

June-August 1995: Summer internship at Japan Atomic Energy Research Institute.

April 1987 - April 1992: Engineer at boiling water nuclear reactor design group in Hitachi Ltd., Ibaraki, Japan.

Projects Funded at University of New Mexico

- October 2008 – September 2009: "Improved Methods for Monte Carlo Particle Transport," Los Alamos National Laboratory. (3rd term; Co-PI with Dr. Prinja; pending)
- August 2007 – September 2008: "Improved Methods for Monte Carlo Particle Transport," Los Alamos National Laboratory. (2nd term; Co-PI with Dr. Prinja, UNM; $ 87,927; $41,566 for Ueki's portion)
- April 2006 – May 2009: "Principal Components and Kolmogorov Complexity in Nuclear Reactor Simulations," University of California Directed Research and Development (UCDRD) funding. (2nd term; LANL/UNM MOU; sole PI on UNM side; $ 25,000, no overhead).
- July 2005 – September 2006: "Improved Methods for Monte Carlo Particle Transport," Los Alamos National Laboratory. (Co-PI with Dr. Prinja, UNM; $ 89,516; $40,000 for Ueki's portion)
- July 2005 – June 2008: "A Multivariate Time Series Method for Monte Carlo Reactor Analysis," Nuclear Engineering Education Research (NEER) Award, Department of Energy, U.S. Government. (Sole PI; $138, 757)
- October 2005 – September 2006: "Variance Reduction for Monte Carlo Photon-Electron Coupled Transport Simulations," Sandia University Research Program, Sandia National Laboratory. (2nd term; sole PI; $40,000, 10% overhead)
- October 2004 – September 2005: "Variance Reduction for Monte Carlo Photon-Electron Coupled Transport Simulations," Sandia University Research Program, Sandia National Laboratory. (Sole PI; $40,000, 10% overhead)
- October 2004 – September 2005: "Principal Components and Kolmogorov Complexity in Nuclear Reactor Simulations," The University of New Mexico and Los Alamos National Laboratory Joint Science and Technology Laboratory (LANL/UNM MOU). (Sole PI on UNM side; $ 22,116, no overhead)

Classes Taught at University of New Mexico

CH-NE 330: Nuclear Engineering Science (sole responsibility of teaching modern physics fundamentals including atomic structures, quantum mechanics, nuclear structures and elementary particles for nuclear engineering undergraduate students)
CH-NE 410: Nuclear Reactor Theory I (sole responsibility)
CH-NE 462: Monte Carlo Techniques (sole responsibility; practicum for seniors)
CH-NE 499/515: Monte Carlo Methods (sole responsibility; advanced class for graduate students)
CH-NE 560: Nuclear Reactor Kinetics and Control (sole responsibility)

Theses Supervised as Chair at University of New Mexico

B.R. Nease, Autocorrelation Analysis of Fission Source Distributions in Monte Carlo Simulations, Master Thesis, The University of New Mexico, 2005.

B.R. Nease, Time Series Analysis of Monte Carlo Neutron Transport Calculations, PhD Dissertation, The University of New Mexico, 2008.

Invited Presentations

• October 2007: "Monte Carlo Method Developments for Nuclear Reactor Analysis," Nuclear Engineering Department of Texas A&M University (Host: Prof Morel)

Selected Publications in Recent Years

11. B.R. Nease, and T. Ueki, "Time Series Analysis and Monte Carlo Methods for Eigenvalue Separation in Neutron Multiplication Problems," submitted to *Journal of Computational Physics*.
10. T. Ueki, "Step-Refined On-The-Fly Convergence Diagnostics of Monte Carlo Fission Source Distribution," submitted to *Nuclear Science and Engineering.*
9. T. Ueki, "Stationarity Diagnostics with Relative Entropy and Wilcoxon Signed Rank in Iterated-Source Monte Carlo Methods," *Nuclear Science and Engineering*, **160** 242-252 (2008).
8. T. Ueki, "On-The-Fly Diagnostics of Particle Population in Iterated-Source Monte Carlo Methods," *Nuclear Science and Engineering*, **158**, 15-27 (2008).
7. T. Ueki, "Monte Carlo Variance Reduction for Energy Profile Calculation at the Electron Emission due to Photon Radiation," *Nuclear Science and Engineering*, **157**, 119-131 (2007).
6. B.R. Nease and T. Ueki, "Time Series Analysis of Monte Carlo Fission Sources: III. Coarse Mesh Projection," *Nuclear Science and Engineering*, **157**, 51-64 (2007).
5. T. Ueki and B.R. Nease, "Time Series Analysis of Monte Carlo Fission Sources: II. Confidence Interval Estimation," *Nuclear Science and Engineering*, **153**, 184-191 (2006).
4. T. Ueki, "Information Theory and Undersampling Diagnostics for Monte Carlo Simulation of Nuclear Criticality," *Nuclear Science and Engineering*, **151**, 283-292 (2005).
3. T. Ueki and F.B. Brown, "Stationarity Modeling and Informatics-Based Diagnostics in Monte Carlo Criticality Calculations," *Nuclear Science and Engineering*, **149**, 38-50 (2005).
2. T. Ueki, F.B. Brown, D.K. Parsons, and J.S. Warsa, "Time Series Analysis of Monte Carlo Fission Sources: I. Dominance Ratio Computation," *Nuclear Sciences and Engineering*, **148**, 374-390 (2004).
1. T. Ueki, F.B. Brown, D.K. Parsons, and D.E. Kornreich, "Autocorrelation and Dominance Ratio in Monte Carlo Criticality Calculations," *Nuclear Science and Engineering*, **145**, 279-290 (2003).