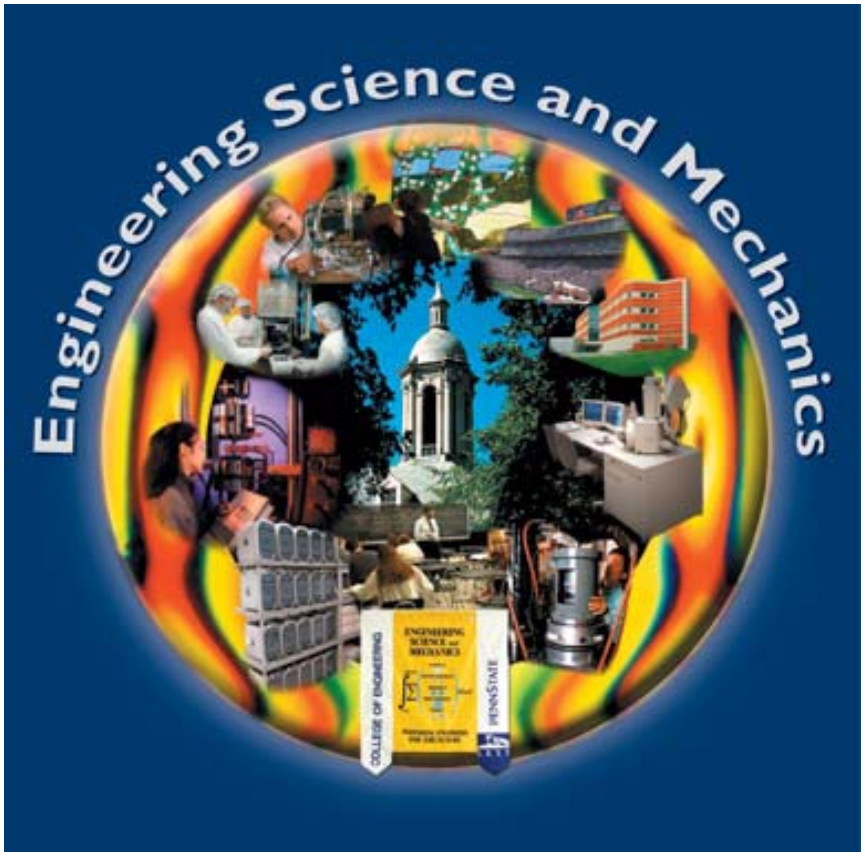
STRATEGIC PLAN
2005 TO 2008



Department of
Engineering Science and Mechanics

Judith A. Todd, Department Head

November 1, 2004

PENNSTATE
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STRATEGIC PLANNING PROCESS

The Engineering Science and Mechanics (ESM) strategic plan was developed through a participatory planning process. Two retreats were held in January 2003 and 2004 to solicit input from the faculty-at-large and identify research, educational and outreach priorities for the department. A Strategic Planning Committee was established in the Fall Semester 2003, chaired by Professor Randall German and continued under the leadership of Professor Bernhard Tittmann in the Spring Semester 2004. The committee solicited input from the faculty, students, staff, the ESM Industrial and Professional Advisory Council (IPAC), Penn State's Office for Planning and Institutional Assessment (Louise Sandmeyer), Penn State's Human Resource Development Center (Pam Farmer) and Leonhard Center Advisory Board Members James Carnes and Charles Kearns. The plan, which was submitted to the full faculty for approval in September 2004, is an evolving document that will be reviewed and updated annually in accordance with ESM's evaluation and assessment plan for the Accreditation Board for Engineering and Technology (ABET).

The ESM Department extends sincere thanks to the Strategic Planning Committee and the IPAC for their leadership in developing this strategic plan:

ESM Strategic Planning Committee:
Bernhard Tittmann (Chair, 2004)
Randall German (Chair, 2003)
Osama Awadelkarim
Joseph Cusumano
Melik Demirel
Stephen Fonash
Albert Segall
Barbara Shaw
Jian Xu

ESM IPAC:
A. Michael Erdman (Chair, 2005)
Barbara Covolus Faust (Chair, 2004)
William Ellingson
Will Gauster
Carol Jantzen
Philip Kraus
Kaynak Kucukpinar
Walter Miller
Rocco Petrilli
Neal Shinn
William Skullney
Alan Wilks
Sam Zamrik

EXECUTIVE SUMMARY

The Department of Engineering Science and Mechanics (ESM) Strategic Plan for 2005-2008 presents strategies and action plans for achieving its vision and mission:

VISION

The Department of Engineering Science and Mechanics (ESM) will be an internationally distinguished department that is recognized for its globally competitive excellence in engineering and scientific accomplishments, research and educational leadership.

MISSION

To develop future state, national and international leaders of scientific and engineering endeavors, the law, medicine, business, politics and governments, who apply a solid foundation in engineering and scientific principles, to impact the well being of the global society, its environment, and future frontiers, yet to be discovered.

With a team of 29 tenure and tenure-track faculty totaling 19.8 full time equivalents [FTE], benchmarking with similar departments across the country indicates that the ESM department's research productivity places it among the top Engineering Science, Mechanical Engineering, Materials Science and Electrical Engineering Departments in the nation. The ESM Department is in an excellent position for growth of the faculty, student bodies and research programs.

To accomplish this growth, ESM will build on its core strengths in mechanics, materials and nanotechnology to develop new research thrusts in bio-nano science and engineering; the Center for Multiscale Wave-Materials Interactions; and health monitoring - *for structures, systems and people*. We will partner with US and international institutions (universities, industry, state and federal agencies, government laboratories) and within Penn State to develop major research and educational initiatives with stable, long-term support. New curricular, educational and outreach initiatives will be developed to support these areas and enhance the department's position as the Honors Program for the College of Engineering. ESM plans to invest in the highest caliber faculty, students and staff and to engage with its alumni, corporate and philanthropic partners to support their mutual development. In consultation with all constituencies, ESM will establish its identity as a leader in the integration of engineering and scientific approaches to derive solutions to diverse engineering problems. Through new promotional strategies, ESM will communicate this identity to achieve our vision and establish the department as the leading Engineering Science and Mechanics Department in the nation and the global arena.

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VISION

The Department of Engineering Science and Mechanics (ESM) will be an internationally distinguished department that is recognized for its globally competitive excellence in engineering and scientific accomplishments, research and educational leadership.

MISSION

To develop future state, national and international leaders of scientific and engineering endeavors, the law, medicine, business, politics and governments, who apply a solid foundation in engineering and scientific principles, to impact the well being of the global society, its environment, and future frontiers, yet to be discovered.

GOALS

- Enhance ESM's position as the Honors Program for the College of Engineering;
- Be multidisciplinary *and* interdisciplinary;
- Create new paradigms for delivery and dissemination of engineering science education;
- Advance the frontiers of science and engineering;
- Develop the theoretical underpinnings of scientific phenomena and their engineering applications;
- Lead in anticipating and pioneering the technologies of the future;
- Transfer leading-edge technologies to industry; and
- Improve the ESM undergraduate and graduate programs through continual assessment.

CORE VALUE

The ESM department will provide a welcoming and respectful climate for a diverse community of students, faculty and staff, recognizing accomplishment and fostering creativity, innovation, intellectual growth, professional development and internationally distinguished leadership.

THE ENVIRONMENT FOR ENGINEERING SCIENCE AND MECHANICS

The next decade promises revolutionary advances for Engineering Science and Mechanics programs that are committed to leadership in innovation and built on a strong foundation of multidisciplinary and interdisciplinary faculty and students. Reports from The National Academies (*"Frontiers of Engineering," "The Engineer of 2020"* and *"Emerging Technologies and Ethical Issues in Engineering" – 2004)* indicate that the dawn of the twenty-first century is seeing:

- unprecedented collaboration among the biological, engineering, life sciences and medical communities;
- new engineering solutions for the security and safety of the global community;
- communications and information technologies that transcend national boundaries; and
- the emergence of the new fields of nano- and bio-nano science and engineering.

Nationwide, Engineering Science and Mechanics programs that embrace such changes are predicted to experience growth in student numbers, research volume and service to industry, government and the professions. In contrast, programs unable to innovate rapidly may find themselves united with programs in, for example, mechanical, electrical, materials, aerospace and/or civil engineering, following a trend observed over the last fifty years.

The Engineering Science and Mechanics Department at Penn State is in an excellent position for growth as it establishes its new programs in bio-nano science and engineering, micro-electro-mechanical systems (MEMS), human and structural health monitoring, wireless communications, multiscale wave-materials interactions, materials and mechanics in collaboration with the Materials Research Institute, Huck Life Sciences Institute, Hershey Medical Center, Applied Research Laboratory and Electro-Optics Center. Such growth is anticipated in a global context through the strong ties of our research and educational programs to academic, industrial and governmental institutions in Europe, Asia, Australia and the Americas. Demand for ESM honors students is very high, with approximately 70 percent continuing to graduate school and 30 percent finding immediate employment in a wide range of industries and government laboratories.

ESM DEPARTMENT PROFILE

The ESM Department comprises 29 tenure and tenure-track faculty (19 Full Professors, 7 Associate Professors and 3 Assistant Professors totaling 19.8 full time equivalent [FTE] positions), 12 graduate faculty, 12.3 staff (6 administrative, 4 technical and 2.3 faculty support staff), 90 undergraduates (including first- and second-year students) and 100 graduate students. The Full Professors hold one Department Head Chair (Breneman), four named Chairs/Professorships (Brush, Kunkle, Morrow and Schell) and four Distinguished Professorships (three active and one emeritus). Assistant Professor Demirel was appointed Pearce Development Professor in the College of Engineering. Two faculty members are responsible for major research centers. Professor Fonash founded the Penn State Nanofabrication Facility and is now Director of the Center for Nanotechnology Education and Utilization (cNEU), which includes the National Nanofabrication Infrastructure Network (NNIN), the Advanced Technology Education program and the flagship Nanomanufacturing Technology program for the Commonwealth of Pennsylvania.

Nanotechnology Camps for High School Students and Teachers

Professor German is Director of the Center for Innovative Sintered Products (CISP) with annual research expenditures in 2003 of $1,644,264 and an industrial membership of approximately 75 companies.

Sintered Boeing Airliner Component

Professor Todd is Director of the Center for Multiscale Wave-Materials Interaction (CMWMI), founded in 2004 with support from the Applied Research Laboratory, College of Engineering, Electro-Optics Center and Materials Research Institute.

The ESM Faculty is highly distinguished and has received the following recognition (listed in alphabetical order) in the last year:

- Prof. Bakis, Fellow ASME International
- Prof. Costanzo, GE Learning Excellence Award
- Prof. Engel, ASEE Board of Directors; Fellow ASEE
- Prof. Fonash, Fellow Electrochemical Society (ECS); Thomas D. Callinan Award, ECS, *for contributions to Dielectric Science and Technology*
- Prof. German, Honorary Doctorate, Universidad Carlos III de Madrid
- Prof. Gray, GE Learning Excellence Award
- Prof. Harbaugh, Department Head of Neurosurgery appointed Professor of Engineering Science and Mechanics
- Prof. Emeritus Hayek, Trente-Crede Silver Medal, Acoustical Society of America
- Prof. Lakhtakia, Distinguished Professor, Penn State
- Prof. Messier, Howard B. Palmer Faculty Mentoring Award; PSES Outstanding Advising Award
- Prof. Pangborn, McKay Donkin Award, Penn State
- Prof. Rose, Fellow ASME International; Fellow British Institute for Nondestructive Testing (NDT); ASME Nondestructive Evaluation (NDE) Division Founders Award
- Prof. Shaw, Executive Committee, NACE
- Prof. Todd, VP Manufacturing, ASME International; Franklin Institute Committee on Arts and Sciences; Committee on Institutional Cooperation (CIC) Academic Leadership Fellow
- Prof. Urquidi-Macdonald, Fellow ASM International
- Prof. Vijay Varadan, Distinguished Professor, Penn State; Professor of Neurosurgery, Hershey Medical Center, Penn State; Fellow ASME International
- Prof. Emeritus Zamrik, ESM Outstanding Alumnus Award

In the 2002-2003 academic year, faculty research expenditures were $15,004,585. The faculty published 192 refereed journal and conference papers, 92 of which were co-authored with graduate and undergraduate students. Between 2000 and 2003, 11 patents were issued with 8 co-authored by students. The faculty is highly entrepreneurial and has participated in the development of businesses related to nanotechnology, powdered materials, condition monitoring and laser processing as well as consulting activities. Detailed descriptions of ESM accomplishments can be found in the publications *ESM Research Overview* and *ESM Performance Metrics.*

From 2000-2005, ESM will have lost ten faculty members: five faculty members (Amateau, Hayek, McNitt, Thompson, Zamrik) have retired, Professors Holmes and McGrath accepted positions at other institutions, Professors Conway and Queeney passed away and Professor Messier has announced his retirement for May 2005. To date, only six of these faculty positions have been filled. Assistant Professor Friedman and Associate Professor Segall joined the faculty in Fall 2002. Assistant Professors Demirel and Xu were appointed in the Fall 2003 to support the department's new research thrust in bio-nano science and engineering and Associate Professors Horn and Lanagan (Associate Director of the Materials Research Institute) were appointed for the Fall Semester 2004. However, there still remains an urgent need to rebuild the faculty.

Engineering Science and Mechanics is the Honors program for the College of Engineering at Penn State, with advanced courses and every undergraduate student conducting a senior research and design thesis. The ESM undergraduate student body has remained approximately constant at 90 students (including first- and second-year students) or 65 majors (junior and senior students). In addition, approximately 40 students are enrolled in the Engineering Mechanics Minor each year. The department teaches service courses on statics; dynamics; strength of materials; mechanical response of engineering materials and engineering applications of materials for the College of Engineering. Enrollment in these courses showed a permanent increase of 400 credit hours in the Fall Semester 2001. The graduate program has remained approximately constant at an enrollment of 100 students for the last four years.

2004 Outstanding Alumni Award Recipient Sam Zamrik visits with E Sc students

BENCHMARKING DATA

As Engineering Science and Mechanics programs are not ranked nationally by US News and World Report, data are presented in Tables 1-8 from the 2003 American Society for Engineering Education (ASEE) Survey for comparable departments that include those entitled Theoretical and Applied Mechanics, Engineering Sciences, Applied Mathematics, Applied and Engineering Physics, Engineering Physics, and Engineering Mechanics.

Table 1 provides data from five "Big Ten Plus" schools (PSU, UIUC, Northwestern, U Wisconsin-Madison and Cornell) plus Virginia Tech University. The data, taken from the 2003 ASEE Survey, are sorted according to research expenditures. The second column of Table 1 reports the number of faculty/researchers who are tenured/tenure track. In column three, for comparison with Penn State, where undergraduates do not declare their majors until their junior year, the number of full-time BS students is reported as the number of junior plus senior students. The number of junior plus senior students per tenure-track faculty member is reported in column four. Column five reports the number of Masters plus PhD graduate students and column six reports the number of Masters plus PhD students per tenure- track faculty member. The total research expenditures for 2003 are reported in column seven. Table 1 shows that Penn State, highlighted in blue, is comparable in faculty size to Virginia Tech, Wisconsin-Madison and the combined Theoretical and Applied Mechanics and the Applied and Engineering Physics Departments at Cornell University. Penn State has the highest research expenditures and MS+PhD students of the group.

Table 2 presents the data in Table 1 by research expenditures per tenure-track faculty member, shown in column eight. As the Penn State ESM Department combines both Science and Mechanics, it is compared in Table 2 to the combined Departments of Applied and Engineering Physics and Theoretical and Applied Mechanics at Cornell University. Based on the data analyzed, it is anticipated that the PSU Engineering Science and Mechanics department would rank very highly if a formal ranking process were to be conducted.

Tables 3, 4 and 5 compare the ESM Department at Penn State with the nation's Top 20 Mechanical Engineering (ME), Materials Science and Engineering (MatSE) and Electrical Engineering (EE) Departments, respectively. Note that these tables do not include departments in which disciplines such as Mechanical and Aerospace Engineering or Electrical and Computer Engineering are combined. The data, taken from the ASEE Survey, are sorted by research expenditures per tenure track faculty member. The ESM Department at Penn State is highlighted in blue and the "Big Ten Plus" institutions are highlighted in yellow. As Tables 3 through 5 do not contain all of the "Big Ten Plus" institutions, Tables 6 through 8 compare the "Big Ten Plus" Departments of Mechanical, Materials and Electrical Engineering (including departments with combined disciplines). The results show that, based on research expenditures, the ESM Department places in the top four Mechanical, Materials and Electrical Engineering Departments in the country and holds a leading position among Engineering Science and Mechanics Departments.

Comparison of the Penn State ESM Department with Departments Related by Discipline as Reported in the 2003 ASEE Survey

TABLE 1

Sorted by Total Research Expenditures

Institution and Department	*Ten-Track Fac (TTFac)*	*Full-Time Jrs+Srs.*	*(Jrs+Srs)/ TTFac*	*Full-Time Masters+ PhDs*	*(Masters+ PhDs)/TTFac*	*Total 2003 Research Expenditures*
Penn State ESM	27	70	2.59	107	3.96	$15,004,585
Cornell Applied & Engineering Physics	16	63	3.94	86	5.38	$10,901,935
Univ of WI Madison Engineering Physics	23	125	5.43	71	3.09	$10,187,000
VA Polytech ESM	28	45	1.61	90	3.21	$5,534,580
Univ of IL at Urbana-Champaign Theoretical & Applied Mechanics	16	32	2.00	66	4.13	$3,795,580
Cornell Theoretical & Applied Mechanics	14	n/a	---	37	2.64	$2,089,805
Northwestern Engineering Sciences/ Applied Mathematics	12	7	0.58	30	2.50	not avail

TABLE 2

Sorted by Research Expenditures Per Tenure-Track Faculty Member

Institution and Department	*Ten-Track Fac (TTFac)*	*Full-Time Jrs+Srs.*	*(Jrs+Srs)/ TTFac*	*Full-Time Masters+ PhDs*	*(Masters+ PhDs)/TTFac*	*Total 2003 Research Expenditures*	***Res $/TTFac***
Penn State ESM	27	70	2.59	107	3.96	$15,004,585	$555,725
Univ of WI Madison Engineering Physics	23	125	5.43	71	3.09	$10,187,000	$442,913
Cornell Applied & Engineering Physics AND Theoretical & Applied Mechanics	30	63	2.10	123	4.10	$12,991,740	$433,058
Univ of IL at Urbana-Champaign Theoretical & Applied Mechanics	16	32	2.00	66	4.13	$3,795,580	$237,224
VA Polytech ESM	28	45	1.61	90	3.21	$5,534,580	$197,664
Northwestern Engineering Sciences/ Applied Mathematics	12	7	0.58	30	2.50	not avail	--

Blue = Penn State ESM Department
Yellow = Big Ten Plus Institution
White = Institution outside the Big Ten Plus

TABLE 3
Comparison of the Penn State ESM Department with the Top 20 ME Departments by Research Expenditures as Reported in the 2003 ASEE Survey

Mechanical Engineering (ME) *Top 20 by Research $*

Sorted by Research Expenditures Per Tenure-Track Faculty Member

Institution	*Ten-Track Fac (TTFac)*	*Full-Time Jrs+Srs.*	*(Jrs+Srs)/ TTFac*	*Full-Time Masters+PhDs*	*(Masters+ PhDs)/TTFac*	*Total 2003 Research Expenditures*	***Res $/TTFac***
Purdue	50	491	9.82	393	7.86	$40,707,782	$814,156
Stanford	32	99	3.09	325	10.16	$23,418,930	$731,842
Penn State ESM	27	70	2.59	107	3.96	$15,004,585	$555,725
Penn State ME	51	657	12.88	176	3.45	$25,623,300	$502,418
Univ of MI	55	458	8.33	418	7.60	$26,726,000	$485,927
Univ of CA Berkeley	45	352	7.82	350	7.78	$21,139,000	$469,756
NC A&T State	14	93	6.64	59	4.21	$6,302,000	$450,143
MIT	61	181	2.97	384	6.30	$23,823,875	$390,555
Texas A&M	48	544	11.33	368	7.67	$18,138,000	$377,875
Univ of WI Madison	33	407	12.33	171	5.18	$12,112,000	$367,030
Univ of MD College Park	45	366	8.13	264	5.87	$14,795,530	$328,790
Univ of Toledo	16	238	14.88	72	4.50	$5,036,916	$314,807
Univ of IA	15	85	5.67	67	4.47	$4,572,000	$304,800
Johns Hopkins	19	60	3.16	80	4.21	$4,765,000	$250,789
Univ of CO-Boulder	20	322	16.10	103	5.15	$4,980,073	$249,004
Auburn	28	203	7.25	92	3.29	$6,769,000	$241,750
Univ of MN Twin Cities	40	419	10.48	172	4.30	$9,242,624	$231,066
Iowa State	32	601	18.78	163	5.09	$6,689,000	$209,031
VA Polytech	33	551	16.70	189	5.73	$6,127,582	$185,684
Ohio State	44	593	13.48	257	5.84	$7,594,000	$172,591
UT Austin	52	494	9.50	350	6.73	$7,468,375	$143,623

Blue = Penn State ESM Department
Yellow = Big Ten Plus Institution
White = Institution outside the Big Ten Plus

TABLE 4
Comparison of the Penn State ESM Department with the Top 20 MatSE Departments by Research Expenditures as Reported in the 2003 ASEE Survey

Materials Science and Engineering (MatSE) *Top 20 by Research $*

Sorted by Research Expenditures Per Tenure-Track Faculty Member

Institution	*Ten-Track Fac (TTFac)*	*Full-Time Jrs+Srs.*	*(Jrs+Srs)/ TTFac*	*Full-Time Masters+PhDs*	*(Masters+ PhDs)/TTFac*	*Total 2003 Research Expenditures*	***Res $/TTFac***
Univ of FL	26	103	3.96	242	9.31	$20,773,000	$798,962
MIT	33	60	1.82	202	6.12	$22,125,097	$670,457
Penn State ESM	27	70	2.59	107	3.96	$15,004,585	$555,725
Iowa State	22	59	2.68	80	3.64	$11,167,000	$507,591
Univ of Penn	12	14	1.17	54	4.50	$5,940,000	$495,000
Univ of WI Madison	14	48	3.43	75	5.36	$6,783,000	$484,500
Univ of VA	19	16	0.84	93	4.89	$8,816,208	$464,011
Univ of MD College Park	14	18	1.29	65	4.64	$6,390,860	$456,490
Drexel	10	27	2.70	63	6.30	$4,500,000	$450,000
NC State	17	61	3.59	68	4.00	$7,511,000	$441,824
Univ of CA Los Angeles	10	59	5.90	76	7.60	$4,043,431	$404,343
Case Western Reserve	11	16	1.45	26	2.36	$4,262,558	$387,505
Cornell	15	44	2.93	45	3.00	$5,644,231	$376,282
SUNY Stony Brook	13	46	3.54	61	4.69	$4,778,350	$367,565
Stanford	11	9	0.82	90	8.18	$3,918,223	$356,202
Ohio State	24	85	3.54	101	4.21	$8,047,000	$335,292
Lehigh	15	48	3.20	47	3.13	$4,855,000	$323,667
Carnegie Mellon	16	32	2.00	59	3.69	$5,135,000	$320,938
Penn State MatSE	32	61	1.91	130	4.06	$10,028,000	$313,375
Univ of IL-Urbana-Champ	27	105	3.89	153	5.67	$8,093,329	$299,753
Univ of MI	19	76	4.00	56	2.95	$4,538,000	$238,842

Blue = Penn State ESM Department
Yellow = Big Ten Plus Institution
White = Institution outside the Big Ten Plus

TABLE 5
Comparison of the Penn State ESM Department with the Top 20 EE Departments by Research Expenditures as Reported in the 2003 ASEE Survey

Electrical Engineering (EE) *Top 20 by Research $*

Sorted by Research Expenditures Per Tenure-Track Faculty Member

Institution	*Ten-Track Fac (TTFac)*	*Full-Time Jrs+Srs.*	*(Jrs+Srs)/ TTFac*	*Full-Time Masters+PhDs*	*(Masters+ PhDs)/TTFac*	*Total 2003 Research Expenditures*	***Res $/TTFac***
Stanford	47	94	2.00	650	13.83	$40,416,444	$859,924
Univ of South Carolina	16	84	5.25	124	7.75	$9,036,792	$564,800
Univ of CA Los Angeles	45	570	12.67	456	10.13	$25,185,601	$559,680
Penn State ESM	27	70	2.59	107	3.96	$15,004,585	$555,725
Princeton	29	70	2.41	189	6.52	$13,105,650	$451,919
Univ of WA	38	388	10.21	286	7.53	$16,761,000	$441,079
Texas A&M	45	398	8.84	315	7.00	$18,452,000	$410,044
Penn State E E	44	510	11.59	231	5.25	$14,819,987	$336,818
Univ of Southern CA	54	213	3.94	1069	19.80	$17,307,062	$320,501
Notre Dame	23	72	3.13	114	4.96	$5,631,393	$244,843
Univ of NV Reno	7	113	16.14	19	2.71	$1,626,553	$232,365
Ohio State	45	626	13.91	327	7.27	$10,381,000	$230,689
Univ of Texas Dallas	38	296	7.79	318	8.37	$6,518,205	$171,532
Univ of Pitt	21	121	5.76	94	4.48	$3,570,000	$170,000
Prairie View A&M	12	94	7.83	22	1.83	$2,023,400	$168,617
Univ of South Florida	14	199	14.21	133	9.50	$2,271,376	$162,241
Univ of CA Santa Cruz	11	56	5.09	42	3.82	$1,767,000	$160,636
Arizona State	50	335	6.70	372	7.44	$7,061,000	$141,220
Univ of Arkansas	20	85	4.25	77	60.00	$2,177,647	$108,882
SUNY Buffalo	18	212	11.78	171	9.50	$1,819,000	$101,056
Univ of NE Lincoln	18	128	7.11	33	1.83	$1,407,834	$78,213

Blue = Penn State ESM Department
Yellow = Big Ten Plus Institution
White = Institution outside the Big Ten Plus

TABLE 6
Comparison of the Penn State ESM Department with the Big Ten Plus ME Departments by Research Expenditures as Reported in the 2003 ASEE Survey

Mechanical Engineering (ME) *Big Ten Plus*

Sorted by Research Expenditures Per Tenure-Track Faculty Member

Institution	*Department Name*	*Ten-Track Fac (TTFac)*	*Full-Time Jrs+Srs*	*(Jrs+Srs)/ TTFac*	*Full-Time Masters+ PhDs*	*(Masters+ PhDs)/TTFac*	*Total 2003 Research Expenditures*	*Res$/TTFac*
Purdue	Mechanical Engineering	50	491	9.82	412	8.24	$40,707,282	$814,146
Stanford	Mechanical Engineering	32	99	3.09	431	13.47	$23,418,930	$731,842
Penn State ESM	Engineering Science & Mechanics	27	70	2.59	107	3.96	$15,004,585	$555,725
Penn State ME	Mechanical Engineering	51	657	12.88	201	3.94	$25,623,300	$502,418
Michigan	Mechanical Engineering	55	458	8.33	450	8.18	$26,726,000	$485,927
University of CA Berkeley	Mechanical Engineering	45	352	7.82	350	7.78	$21,139,000	$469,756
MIT	Mechanical Engineering	61	181	2.97	386	6.33	$23,823,875	$390,555
Univ of Wisconsin Madison	Mechanical Engineering	33	407	12.33	190	5.76	$12,112,000	$367,030
Iowa	Mechanical Engineering	15	85	5.67	67	4.47	$4,572,000	$304,800
Cornell	Mechanical & Aerospace Engineering	25	233	9.32	132	5.28	$6,842,424	$273,697
Minnesota	Mechanical Engineering	40	419	10.48	248	6.20	$9,242,624	$231,066
Univ of IL Urbana-Champaign	Mechanical & Industrial Engineering	46	439	9.54	294	6.39	$9,569,478	$208,032
Ohio State	Mechanical Engineering	44	593	13.48	257	5.84	$7,594,000	$172,591
Carnegie Mellon	Mechanical Engineering	22	187	8.50	92	4.18	$3,342,000	$151,909
Univ of Texas Austin	Mechanical Engineering	52	491	9.44	420	8.08	$7,468,375	$143,623
Michigan State	Mechanical Engineering	35	475	13.57	116	3.31	$4,273,000	$122,086
GA Tech	Mechanical Engineering	73	531	7.27	647	8.86	no data	no data
Northwestern	Mechanical Engineering	28	75	2.68	99	3.54	no data	no data

Blue = Penn State ESM Department
Yellow = Big Ten Plus Institution

TABLE 7
Comparison of the Penn State ESM Department with the Big Ten Plus MatSE Departments by Research Expenditures as Reported in the 2003 ASEE Survey

Materials Science and Engineering (MatSE) *Big Ten Plus*

Sorted by Research Expenditures Per Tenure-Track Faculty Member

Institution	*Department Name*	*Ten-Track Fac (TTFac)*	*Full-Time Jrs+Srs*	*(Jrs+Srs)/ TTFac*	*Full-Time Masters+ PhDs*	*(Masters+ PhDs)/TTFac*	*Total 2003 Research Expenditures*	*Res$/TTFac*
MIT	Materials Science and Engineering	33	60	1.82	202	6.12	$22,125,097	$670,457
Penn State ESM	Engineering Science & Mechanics	27	70	2.59	107	3.96	$15,004,585	$555,725
Univ of Wisconsin Madison	Materials Science & Engineering	14	48	3.43	78	5.57	$6,783,000	$484,500
Cornell	Materials Science and Engineering	15	44	2.93	45	3.00	$5,644,231	$376,282
Stanford	Materials Science and Engineering	11	9	0.82	128	11.64	$3,918,223	$356,202
Ohio State	Materials Science and Engineering	24	85	3.54	101	4.21	$8,047,000	$335,292
Carnegie Mellon	Materials Science and Engineering	16	32	2.00	65	4.06	$5,135,000	$320,938
Penn State MatSE	Materials Science and Engineering	32	61	1.91	132	4.13	$10,028,000	$313,375
Univ of IL Urbana-Champaign	Materials Science and Engineering	27	105	3.89	158	5.85	$8,093,329	$299,753
Michigan	Materials Science and Engineering	19	76	4.00	60	3.16	$4,538,000	$238,842
Purdue	Materials Engineering	14	68	4.86	54	3.86	$3,235,316	$231,094
University of CA Berkeley	Materials Science and Engineering	15	54	3.60	88	5.87	$2,141,000	$142,733
GA Tech	Materials Science & Engineering	22	29	1.32	108	4.91	no data	no data
Northwestern	Materials Science & Engineering	20	47	2.35	199	9.95	no data	no data

Blue = Penn State ESM Department
Yellow = Big Ten Plus Institution

TABLE 8
Comparison of the Penn State ESM Department with the Big Ten Plus EE Departments by Research Expenditures as Reported in the 2003 ASEE Survey

Electrical Engineering (EE) — *Big Ten Plus*

Sorted by Research Expenditures Per Tenure-Track Faculty Member

Institution	*Department Name*	*Ten-Track Fac (TTFac)*	*Full-Time Jrs+Srs*	*(Jrs+Srs)/ TTFac*	*Full-Time Masters+ PhDs*	*(Masters+ PhDs)/TTFac*	*Total 2003 Research Expenditures*	*Res$/TTFac*
Stanford	Electrical Engineering	47	94	2.00	898	19.11	$40,416,444	$859,924
University of CA Berkeley	Electrical Engineering and Computer Sciences	86	744	8.65	569	6.62	$61,919,000	$719,988
Penn State ESM	Engineering Science & Mechanics	27	70	2.59	107	3.96	$15,004,585	$555,725
Purdue	Electrical and Computer Engineering	70	715	10.21	505	7.21	$38,314,502	$547,350
MIT	Electrical Engineering & Computer Science	116	629	5.42	927	7.99	$59,009,270	$508,701
Univ of Wisconsin Madison	Electrical & Computer Engineering	41	460	11.22	422	10.29	$16,404,000	$400,098
Univ of IL Urbana-Champaign	Electrical and Computer Engineering	89	999	11.22	581	6.53	$35,595,317	$399,947
Cornell	Electrical and Computer Engineering	42	299	7.12	289	6.88	$16,575,988	$394,666
Carnegie Mellon	Electrical and Computer Engineering	50	289	5.78	312	6.24	$19,007,000	$380,140
Penn State EE	Electrical Engineering	44	510	11.59	276	6.27	$14,819,987	$336,818
Ohio State	Electrical Engineering	45	626	13.91	327	7.27	$10,381,000	$230,689
Michigan State	Electrical and Computer Engineering	34	363	10.68	186	5.47	$6,129,000	$180,265
Iowa	Electrical and Computer Engineering	16	88	5.50	68	4.25	$2,449,000	$153,063
Minnesota	Electrical and Computer Engineering	43	320	7.44	525	12.21	$6,262,422	$145,638
Univ of Texas Austin	Electrical and Computer Engineering	59	858	14.54	694	11.76	$4,163,144	$70,562
GA Tech	Electrical & Computer Engineering	113	828	7.33	968	8.57	no data	no data
Northwestern	Electrical and Computer Engineering	29	129	4.45	164	5.66	no data	no data

Blue = Penn State ESM Department
Yellow = Big Ten Plus Institution

STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS (SWOT ANALYSES)

Table 9 provides the results of the ESM Department's self analysis of the strengths, weaknesses, opportunities and threats (SWOT) to the ESM program. These data have been collected in consultation with our constituencies (faculty, staff, students, IPAC [Industrial, Professional Advisory Council]) as part of our ABET review and assessment of the ESM program.

TABLE 9: ESM STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS

Strengths	Opportunities
• World-class, distinguished, collegial faculty, research leaders and innovators • High quality undergraduate and graduate students • Outstanding, supportive staff • Excellent environment for teaching and research with well-equipped facilities • Multidisciplinary and interdisciplinary • $15.0M research expenditures ensures multiplicity of research experiences • Theoretical/modeling expertise • Flexible, rigorous, academic program with strong emphasis on teaching and course development • Focus on issues/problems/paradigms for the future • Excellent perception of faculty dedication to teaching by PSU students • Small student numbers facilitate positive interactions with the faculty in class, the senior design projects and ESM research programs • The E Sc undergraduate program provides excellent preparation for graduate school, lifelong learning and a wide range of employers' needs	• Recognition and growth opportunities for faculty, staff and students • Major funding opportunities provided by multidisciplinary, intra- and inter-institutional collaborations • New research initiatives for growth of research programs and student body (e.g. bio-nanotechnology, medicine, nano-mechanics, multiscale wave-materials interactions, materials, energy-related research, health monitoring, microelectronics, homeland security) • New curricular initiatives to grow student body (bio-nano technology, nano minor, mechanics) • Active mentoring of faculty, staff and students • Increased industrial/governmental collaborations • Sponsorship of conferences • Increased visibility of ESM Department • Leadership development for the global workforce • Involvement of all constituencies in strategic planning • Continual assessment and improvement of the ESM programs

TABLE 9: ESM STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS
(continued)

Weaknesses	Threats
• Identity and visibility of the ESM programs • Faculty and students in emerging areas need to grow to critical mass • High teaching loads due to service courses • Undergraduate and graduate student numbers • Lack of PSU intellectual property (IP) goals and directions • PSU billing delays • Inadequate PSU support for International Tariff and Arms/Department of Commerce export and regulatory issues • Laboratory space for growing research programs • Teaching laboratories and demonstration equipment for new programs • Reward structure for preparing new essential classes • Increased entrepreneurial skills required by faculty	• Impending retirements • Burden of competitive start-up packages for new faculty • Long-term budgetary concerns • Competition for resources nationally and within PSU • Limited space for growth • Long visa application process for international students • Declining numbers of graduate students (US and international) • Ability to recruit highest quality graduate students • Loss of highly sought E Sc undergraduate students to top US institutions and within PSU • Impact of "sensitive but not classified" designation on research programs • Diminished funding from governmental agencies

The SWOT analyses provided the background data for defining our guiding principles and developing the strategic goals and action plans discussed in the following sections.

E Sc students celebrate graduation 2003

GUIDING PRINCIPLES

The ESM Department's strategic plan has been developed with the following guiding principles:

A) *Attract and develop the highest quality faculty, students and staff in a supportive teaching, learning and working environment;*

B) *Create the very finest educational, research and outreach programs; and*

C) *Promote a culture of open communication, mutual trust and respect, professionalism, teamwork and superior service.*

The guiding principles provide a strong foundation for the ESM Department's Strategic Goals.

Six critical issues and their associated strategic goals are identified in the following section. Each strategic goal is then discussed in detail followed by an action plan for implementing each goal.

E Sc students experience one-on-one collaborations with faculty through course experience, participation in the department's summer research experience for undergraduate students program and the senior research and design capstone project.

CRITICAL ISSUES AND STRATEGIC GOALS

CRITICAL ISSUE 1:
RESEARCH

Growth of ESM's research programs will require new multidisciplinary research initiatives.

STRATEGIC GOAL 1: Develop new research initiatives that position ESM and Penn State as leaders in the international community.

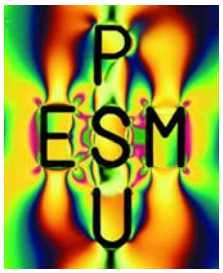
CRITICAL ISSUE 2:
EDUCATION AND OUTREACH

New educational and outreach initiatives must be developed to support our new research areas.

STRATEGIC GOAL 2: Enhance the Engineering Science curriculum by developing innovative, nationally recognized education programs that are disseminated to the widest possible audience.

CRITICAL ISSUE 3:
IDENTITY AND COMMUNICATIONS

The Engineering Science and Mechanics fields are less well-recognized than the traditional engineering disciplines.



STRATEGIC GOAL 3: Improve the recognition of the Engineering Science and Mechanics fields by academia, the professions, industry and government through enhanced communications.

CRITICAL ISSUE 4:
RECRUITMENT, RETENTION, PLACEMENT

Economic and global factors create an uncertain climate for recruitment and retention of faculty and students.

STRATEGIC GOAL 4: Develop new strategies to recruit and retain faculty, students and staff and enhance placement of ESM students.

CRITICAL ISSUE 5:
DEVELOPMENT AND ALUMNI RELATIONS

ESM's alumni, corporate and foundation relations activities and philanthropic support bases need to be strengthened.

STRATEGIC GOAL 5: Enhance our alumni, corporate and foundation relations, development and marketing activities to increase support for key ESM initiatives.

CRITICAL ISSUE 6:
ADMINISTRATION AND ORGANIZATION

Streamlined organization and effective administration can be realized through continuous quality improvement.

STRATEGIC GOAL 6: Implement new administrative and organizational practices in accordance with ESM's strategic plan.

STRATEGIC GOALS AND ACTION PLANS

Strategic Goal 1:
Develop New Research Initiatives that Position ESM and Penn State as Leaders in the International Community

During the next three years, the ESM Department's priorities are to develop three new university-wide research initiatives in:

- Bio-nano Science and Engineering;
- The Center for Multiscale Wave-Materials Interactions (CMWMI); and
- Health Monitoring - *for Structures, Systems and People.*

We shall also continue our strong leadership and development of the:

- National Nanofabrication Infrastructure Network (NNIN); and
- The Center for Innovative Sintered Products (CISP).

The **Bio-nano Science and Engineering** initiative, supported by the Materials Research Institute, Huck Life Sciences Institute, Colleges of Engineering and Science and the Hershey Medical Center, aims to integrate our strengths in engineering and nanotechnology with the biological sciences to create new generations of biosensors, bioelectronics, smart implants, biomimetic materials, drug delivery systems and tissue regeneration systems. Professor Demirel, whose expertise is in computational biology, biodetection and experimental protein design for materials assembly using fibril and fluorescence proteins, and Professor Xu, whose interests lie in the integration of biological molecules with semiconductors to make the next generation of bio-opto-electronic sensors, devices and systems, were appointed in the Fall Semester 2003. Two additional appointments are planned for 2005.

The **Center for Multiscale Wave-Materials Interactions (CMWMI)**, supported by the Applied Research Laboratory (ARL), College of Engineering, Electro-Optics Center (EOC) and the Materials Research Institute (MRI) was founded in 2004 to bring together approximately sixty faculty with interests in the interactions that occur when materials are exposed to individual wavelengths and novel combinations of waves. Examples might include combinations of laser and microwave beams for material processing with ultrasonics for component diagnostics or applications of excimer and infrared wavelengths for micromachining materials. Space for the Center, a 3 KW Nd-YAG laser and a frequency tripled $NdVO_4$ laser have been committed by ARL. CO_2 and YAG lasers have been committed by ESM to be placed in the open-access center, Research West Building, that should be operational by 2005. CMWMI by-laws and operating procedures will be developed, and a Multi-Investigator University Research Initiative (MURI) proposal will be submitted from the Center. It is envisaged that the Center will be the catalyst for new research initiatives (ranging from fundamental interactions of atto [10^{-18}] and femto [10^{-15}] second pulses with matter to the bending of ship plate by residual stresses induced by high power lasers) that will provide the foundation for a future NSF Engineering Research Center proposal.

Health Monitoring - *for Structures, Systems and People*: The term health monitoring has traditionally been applied to engineering structures and refers to the use of nondestructive techniques such as acoustics, ultrasonics, thermal imaging, x-rays, etc. to determine whether a structure has internal flaws or cracks that may result in catastrophic failure. This field is commonly called "Nondestructive Evaluation." The ESM department is broadening the concept of health monitoring, in view of our strengths in mechanics, materials, corrosion, sensors, bio-nano technology, MEMS, wireless communications, nondestructive evaluation, neural networks and data mining, to extend it beyond engineering structures and systems to biological systems and even the human body. Indeed, the new field of health monitoring is not merely diagnostic but uses signal interpretation and smart systems for real-time intervention to prevent disasters and save lives. During the next three years, ESM will strengthen its ties with the Hershey Medical Center, which has made a strong commitment to developing new thrusts in neurosurgery and cancer research. New initiatives will be established with the Departments of Neurosurgery, Pediatrics, Psychiatry, Surgery and Neonatal Care related to Parkinson's Disease, epilepsy, Alzheimer's Disease, sleep apnea, cough monitoring, neonatal infant breath monitoring and biofilm infections, among others. This area incorporates a new vision for our mechanics research and represents a major potential growth area for the department. We anticipate hiring two faculty members (Fall 2006 and Fall 2007) with strong mechanics backgrounds to develop this field and see the evolution of these activities leading to the development of a major center with international recognition at Penn State.

National Nanofabrication Infrastructure Network (NNIN): Under the leadership of ESM faculty member, Professor Fonash, Penn State became one of the National Science Foundation (NSF) National Nanotechnology University Network (NNUN) nodes, with $32 million in instrumentation and $18 million in government, state, industry and university support from 1998-2003. In 2004, Professor Fonash led Penn State in successful re-competition for the NSF National Nanotechnology Infrastructure Network (NNIN). This nationally acclaimed facility attracts faculty, students and industries world-wide as users and has developed the premier outreach nanotechnology education programs in the Commonwealth of Pennsylvania and the nation. These programs have been recognized by the establishment of the Center for Nanotechnology Education and Utilization (cNEU), directed by Professor Fonash, at Penn State. The PSU NNIN facility is exceptionally well equipped with probe, lithography, etching, materials modification and deposition tools for nanofabrication and microfabrication to support the needs of the bio-nano faculty and students. During the next three years, significant growth of NNIN-related research programs is envisaged.

Center for Innovative Sintered Products (CISP): Professor Randall German has developed the premier US Center related to powdered materials and sintered products, supported by approximately 75 participating industries. This internationally recognized center conducted, in 2003, $1,622,264 in annual research expenditures, published 29 papers, supported 14 graduate and 25 undergraduate students, hosted two member conferences and conducted 15 short courses for industry. Despite fluctuations in the global economy, CISP expects to reach an annual operating budget of $2,000,000 within the next three years.

RESEARCH ACTION PLAN

Critical Issue:
Growth of ESM's research programs will require new multidisciplinary research initiatives.

Strategic Goal:
Develop new research initiatives that position ESM and Penn State as leaders in the international community.

Research Assessment Team:

Bio-nano faculty	Demirel, Xu, new, new
Multiscale Wave-Materials Interactions	Todd, Segal, Tittmann, Lanagan, Xu
Health Monitoring	Cusumano, Rose, VK Varadan, VV Varadan
NNIN	Fonash, Catchmark, Awadelkarim
CISP	German, Smid
IPAC member	Miller, Shinn
ESM student representatives	tbd (undergraduate); tbd (graduate)

Action Items:	**Date**
Bio-nano Science and Engineering	
• Add two new faculty research areas	**2005 – Fall**
• Develop new bio-nano research laboratories	**2005/06**
• Submit NSF career awards	**2005/06/07**
Center for Multiscale Wave Materials Interactions (CMWMI)	
• Collaborative Laser Laboratory fully renovated facility with installed equipment to be available to faculty and students	**2005 (or earlier)**
• Opening ceremony with invited agency leaders	**2005**
• Decision date on MURI proposal submitted in collaboration with CMWMI	**2005**
• Decision date on DURIP proposal submitted in collaboration with CMWMI	**2005**
• Three to five key research areas identified with proposals submitted to agencies	**2005/06**
• Preparation for Engineering Research Center proposal	**2006/07**
Health Monitoring – *for Structures, Systems and People*	
• Identify university-wide faculty contributors to this initiative	**2005**
• Develop and implement a new vision for mechanics research, education and outreach at Penn State in collaboration with COE faculty and linked to the national mechanics initiative led by VA Tech	**2005 - 2008**
• Submit proposal to host international mechanics conference at PSU	**2006**
• Partner with Hershey Medical Center faculty to develop major new research initiatives	**Ongoing**
• Add new faculty research area	**2006 - Fall**
• Add second faculty research area	**2007 - Fall**
National Nanofabrication Infrastructure Network (NNIN)	
• Increase the research and user base of NNIN to enhance Penn State's international stature in nanotechnology	**Ongoing**
Center for Innovative Sintered Products (CISP)	
• Increase research and industrial collaborations to build CISP operating budget to $2,000,000/year	**2005-2008**
Overall Department	
• Identify collaborative opportunities to increase ESM's research base	**Ongoing**
• Increase support for Research Opportunities for Undergraduates	**Ongoing**
• Communicate new research opportunities to graduate students	**Ongoing**
• Develop new industrial research collaborations	**Ongoing**

Strategic Goal 2: Enhance the Engineering Science Curriculum by Developing Innovative, Nationally Recognized Education Programs that are Disseminated to the Widest Possible Audience

Innovation of the ESM curricula will be essential to support our research initiatives described in Strategic Goal 1 and our recruitment and retention initiatives described in Strategic Goal 4.

Undergraduate Curriculum

A complete review of our undergraduate program objectives, course offerings and course contents will be made in accordance with College of Engineering guidelines and the review and assessment of our program for ABET. The review, led by ESM's Curriculum Assessment Team, will also explore the potential for delivering the undergraduate program within 128 credits (excluding Health and Physical Science Activity). The E Sc undergraduate program has very strong foundations in mathematics and the physical and chemical sciences to support our research programs in mechanics, materials and nano-/micro-electronics. It is now important to include foundation course options in the biological/biomedical sciences and related disciplines to support our new initiatives in bio-nano science and engineering. Potentially, this could provide three pathways through our curriculum: a mechanics pathway; a materials pathway; and a bio-nano science and engineering pathway. These pathways should attract more students to the E Sc program. In addition, the flexibility of our program will permit students to customize their basic science options and their technical electives toward a research area of their interest in their senior year. The Curriculum Assessment Team will explore the feasibility of this approach. ESM will collaborate with the Leonhard Center to prepare the World Class Engineers of the future.

ESM is committed to integrating professional components that include ethics, diversity, teamwork, global awareness, safety, sustainability, communications and environmental impact issues throughout our curriculum. Assessment of the improvements in our programs will be based on quantifiable outcomes from, for example, surveys, exit interviews and student portfolios.

Key Curricular Initiatives

Curricular initiatives that impact both our undergraduate and graduate programs are proposed in:

- mechanics education;
- bio-nano science and engineering; and
- multiscale wave-materials interactions.

ESM has a strong commitment to **mechanics education** that involves problem-based and hands-on learning. In the Fall 2004, ESM will pioneer offering all 500 students enrolled in Statics a computer simulation, laboratory experiment and computer analysis experience. The outcome of this experiment will be assessed in 2005 to see whether this should be a permanent addition to the curriculum. ESM faculty members are currently developing a new problem-based learning approach to dynamics, together with new textbooks in both statics and dynamics, all of which will be assessed by E Sc honors students. An annual retreat to review and innovate the undergraduate mechanics service courses offered by faculty at 18 Penn State campuses teaching mechanics will be led by ESM. This will ensure consistent standards in mechanics education university-wide.

ESM, in collaboration with the Departments of Architectural, Aerospace, Civil, Industrial and Manufacturing and Mechanical and Nuclear Engineering, proposes to lead an initiative for a new vision for mechanics education and research that is linked to the national initiative being coordinated by Virginia Tech. A college-wide review of mechanics courses and future educational needs should permit the development of enhanced mechanics offerings to complement new research directions in the College of Engineering.

ESM's course offerings in **nano and bio-nano science and engineering** will develop rapidly as the new faculty members develop undergraduate and graduate courses to support their research programs. ESM is pioneering an undergraduate nano science and engineering minor, comprising six courses in categories approved by faculty engaged in nanotechnology across the Penn State system. It is hoped that, through approval of further course options, this will become the model for a university-wide minor in nano science and engineering. The new Center for Nanotechnology Education and Utilization (cNEU) will be pivotal in ESM's **outreach** activities. As the home of the Nano-Manufacturing Technology program for workforce development in the State of Pennsylvania, it is anticipated that the Center will develop new programs in nanotechnology utilization in addition to expanding both educational and utilization programs beyond the Pennsylvania borders to develop comparable programs in other states.

Five new graduate courses (also options for approved senior undergraduate students) in Laser Materials Processing have been approved and will be offered sequentially starting Fall 2004 to support the **Center for Multiscale Wave-Materials Interactions (CMWMI)**. A proposal will be submitted to develop four of these graduate courses in distance learning format for a graduate certificate in Laser Materials Processing targeted at approximately 350 industries associated with ARL, EOC and CISP, the Navy and even an international audience. The certificate would be available to graduate students pursuing advanced degrees and industrial participants completing the four-course sequence. The course credits would be applicable towards an approved graduate degree. This web-based learning initiative should enhance both our **outreach** and **recruitment** activities and may create a significant revenue stream for the department.

On completion of the review of our undergraduate program, ESM will initiate a complete review of **graduate course offerings**, content and credit hours in accordance with Graduate School guidelines. A proposal for an integrated undergraduate/graduate (IUG) program leading to BS/MS degrees in five years has been submitted to the Graduate School. It is anticipated that this program will be in place in 2005 and will have a significant impact on our graduate recruitment activities.

ESM plans further growth of our **outreach** to industry and the profession through short courses in corrosion offered by Professor Shaw and in powdered/sintered materials by CISP. ESM is committed to enhancing our educational outreach to a diverse community of high school and college students through individual and multi-investigator research grants and new ESM initiatives in collaboration with Barbara Bogue, former Director of the Women in Engineering Program (WEP), who joined ESM in the Fall Semester 2004. Under Professor Bogue's leadership, Penn State was one of only seven institutions to receive a 2004 Presidential Award for Excellence in Science, Mathematics and Engineering mentoring for the WEP.

EDUCATION AND OUTREACH ACTION PLAN

Critical Issue:
New educational and outreach initiatives must be developed to support our new research areas.

Strategic Goal:
Innovate the Engineering Science curriculum to include nationally recognized education programs that are disseminated to the widest possible audience.

Education and Outreach Innovation Team:

Undergraduate Officers	Lissenden, Masters, Messier
Graduate Officer	Lakhtakia
Bio-nano faculty	Demirel, Xu, Horn, new, new
Mechanics faculty	Cusumano, Gray, Costanzo, Friedman, Rose, Salamon, Segall, Ventsel
Diversity	Bogue
Staff	Orr, Ritter, Croyle, Business Coordinator, Daub, Elder
IPAC member	Erdman, Faust
ESM student representatives	tbd (undergraduate); tbd (graduate)

Action Items:	**Date**
Undergraduate Curriculum	
• Review program objectives, courses, credit hours, assessment	**2005-2006**
• Introduce foundation courses in biological sciences and identify curriculum pathways	**2005-2006**
• Introduce new minor and new courses in bio-nano science and engineering	**2005-2008**
• Assess experimental program introduced in Statics	**2005**
• Assess problem-based learning and new text book for dynamics	**2005-2008**
• Retreat for mechanics faculty from 18 Penn State campuses	**Annual**
• Initiate discussions on new vision for mechanics education and research	**2005-2007**
• Review program and course objectives and assess program outcomes	**Ongoing**
• Integrate professional components throughout curriculum	**Ongoing**
• Collaborations with Leonhard Center – World Class Engineer and ABET	**Ongoing**
Graduate Curriculum	
• Review graduate course offerings, content, credit hours, new initiatives	**2006-2007**
• New courses in bio-nano science and engineering	**2005-2008**
• New courses in laser materials processing	**2005-2007**
• Certificate Program in laser materials processing with web-based learning	**2006-2008**
• Integrated Undergraduate/Graduate Degree Program	**2005**
• Initiate discussions on new vision for mechanics education and research	**2005-2007**
Outreach	
• Development of cNEU workforce education and utilization programs	**2005-2008**
• Initiate CMWMI outreach to industry	**2005**
• Corrosion and CISP short courses	**Ongoing**
• New diversity outreach initiatives with Barbara Bogue	**2005**

Strategic Goal 3: Improve the Recognition of the Engineering Science and Mechanics Fields by Academia, the Professions, Industry and Government through Enhanced Communication

The Engineering Science and Mechanics program at Penn State has several unique features compared to traditional engineering programs:

- It is the honors program for the College of Engineering;
- Flexible pathways and four electives permit students to customize their individual programs of study;
- The program is both multidisciplinary and interdisciplinary;
- Each student conducts a one-year senior research and design honors thesis in an area of his or her choice; and
- Each student is assigned an academic advisor throughout his or her program and also a research advisor in the final year.

The E Sc program served as a model for the University-wide Schreyer Honors Program that was founded in 1980 and is open to all majors. In 2005, the ESM Department will be celebrating its fiftieth year of honors education for the College of Engineering at Penn State.

During the next three years, ESM will develop a concerted campaign to increase the recognition of our non-traditional engineering discipline by high school students, the academic community, potential employers and the public. ESM will form both an Undergraduate and a Graduate Student Council to provide representatives to the Identity and Communications Team. This team will develop consensus regarding a "brand" or identity that will position ESM as a top choice for high quality students interested in flexible, rigorous, research oriented and fun undergraduate and graduate experiences. We shall target specific high school audiences, academic institutions and the industries that employ our alumni to forge collaborative links and employment opportunities for our students. Considerable effort will be devoted to increasing the external recognition of the program through nomination of our students, faculty and staff for professional growth, national and international awards and communicating these accomplishments to the public.

ESM will explore the feasibility for developing a "Big Ten Plus" or a national Engineering Science and Mechanics Council to promote the international recognition of our disciplines and benchmarking of our institutions. The feasibility of organizing such a Council through the Society of Engineering Science will be explored.

Critical to ESM's success will be the development of a new suite of communications materials that includes: a commanding web presence; promotional materials for our programs, research and technology transfer activities; electronic and print newsletters; and media releases to major news organizations. ESM will actively involve our IPAC, alumni and students to critique our communications materials and act as ambassadors for our program with industry, government, academia and high schools. Our new promotional materials will impact our recruitment and retention of students, faculty and staff and also enhance our relations with our alumni and industry.

IDENTITY AND COMMUNICATIONS ACTION PLAN

Critical Issue:
The Engineering Science and Mechanics fields are less well-recognized than the traditional engineering disciplines.

Strategic Goal:
Improve the recognition of the Engineering Science and Mechanics fields and communicate their stature in academia and the professions.

Identity and Communications Assessment Team:

Faculty	Todd, Messier, Horn, Suliman
Staff	Sanders, Croyle, Ames, Long, Lindenberg, Liadis
IPAC member	Wilks
ESM student representatives	tbd (undergraduate); tbd (graduate)

Action Items:	Date
Identity	
• Develop identity for ESM Department	**2005**
• Define target audiences – schools, academia, industry, government	**2005-06**
• Create graduate and undergraduate student councils	**2005**
• Construct marketing strategy and communications plan for targets	**2005-06**
• Develop materials to increase the public awareness of ESM	**Ongoing**
Communications	
• Evaluate impact of web presence on the ESM image	**2005**
• Evaluate tagline for the department	**2005**
• Create plan for development of promotional materials	**2005-2007**
• Prepare Centennial promotional newsletter	**2005**
• Develop plan for web site redesign incorporating feedback from constituencies	**2005-2006**
• Update ESM publications – metrics, research, faculty brochure	**Ongoing**
• Promote recognition of student, faculty and staff accomplishments	**Ongoing**
Excite Young People to Pursue Studies in ESM	
• Organize ESM student ambassadors program	**2005**
• Involve IPAC and alumni in publicizing the ESM program	**Ongoing**
• Faculty visits to target institutions	**Ongoing**
• Society of Engineering Science chapter to sponsor development of student publicity materials, CD-ROM, etc.	**2005-2006**
• Increase media relations in major news publications	**Ongoing**

Strategic Goal 4: Develop New Strategies to Recruit and Retain Faculty, Students and Staff and Enhance Placement of ESM Students

Faculty

ESM's bio-nano science and engineering initiative seeks to recruit from a new generation of faculty with experience in both engineering and the biological sciences. While the applicant pool is limited, ESM has been successful in adding Professors Demirel and Xu with computational materials, electrical engineering and biological systems expertise. The second recruitment phase will place strong emphasis on attracting faculty with foundations in chemical and biomedical engineering to complement and build this group to critical mass. For the "health monitoring" positions, ESM will develop a plan to recruit faculty with strong foundations in mechanics and research interests that could include multiscale mechanics (nano- to macro-scale); critical asset protection for homeland security; and the medical and health care fields. New strategies must be developed to identify the institutions and research groups developing such interdisciplinary faculty in order to provide strong applicant pools for these positions.

The ESM recruitment plan will also consider forging new collaborations such as that between Dr. Robert Harbaugh, Head of Neurosurgery at the Hershey Medical Center, who has received a joint appointment in the ESM Department and Professor Vijay Varadan, Distinguished Professor of Engineering Science and Mechanics, who has received a joint appointment as Professor of Neurosurgery. Plans are currently under development to attract a major research center on Parkinson's Disease to Penn State.

Robert Harbaugh

ESM welcomes the opportunity to diversify the faculty as we grow the department. A major opportunity for the department and College of Engineering may present itself through the NSF grant proposal "ADVANCE", aimed to increase the visibility, recruitment and retention of women and minority faculty. Should a call for proposals be issued in 2005, Professors Todd, Bogue and Irwin will lead the development of an ADVANCE proposal for the College of Engineering.

Critical to the growth of the faculty is the development of the resources needed for start-up packages for new faculty. Professor Todd will work with the College of Engineering and University Development Office to pursue philanthropic support for such initiatives (from corporations, foundations, alumni and friends) as described in Strategic Goal 5.

Students

At a time when market uncertainties, homeland security and stricter visa regulations are impacting our recruitment activities, new strategies are required to ensure stability and growth of our graduate and undergraduate programs. An immediate strategic goal is to increase our graduate enrollment significantly to complement the ESM department growth of its faculty and research programs. ESM has begun to develop agreements with schools that

could provide high quality students for our graduate program. Agreements are already in place with Millersville and Edinboro Universities in Pennsylvania, the University of Salerno, Italy, and one is currently under discussion with a leading undergraduate institution. Two students, one each from Millersville and Edinboro entered the graduate program in Fall 2004. The Recruitment and Retention Team will develop a plan to implement agreements with specific target institutions to provide a steady stream of excellent students for our graduate program. We also plan to develop similar arrangements with high schools to build our undergraduate program. The Recruitment, Retention and Placement Team will design and implement an aggressive marketing campaign for our new initiatives in bio-nano science and engineering, the integrated undergraduate/graduate (IUG) program and the health monitoring areas, all of which are expected to attract new groups of students to the ESM programs.

Retention

Retention of students in the department's undergraduate and graduate programs is very high as reflected by the approximately constant enrollments over the last two years. This can be attributed to the selectivity of students accepted to the program and the individual advising and personal attention given to the students. The graduate program has approximately 5 percent turnover of students due to inability to find support as a Research Assistant or failure to pass the PhD candidacy examination. The undergraduate program has approximately 10 percent turnover of students who: identify other majors as their primary interest due to the multidisciplinary nature of our program (a discovery supported by ESM); find their preparation inadequate for the rigors of the E Sc curriculum; or prefer a less flexible major. The Recruitment, Retention and Placement Team will develop a plan for increasing both the quality and numbers of ESM students in our programs, increasing the quality of the advising experience, and improving our acceptance criteria to ensure that all entering students are qualified and provided with the support they need to succeed.

ESM will develop mentoring programs for both faculty and staff to support them through the University's promotion processes and in developing the qualifications worthy of internal and external awards.

Placement

Approximately 70 percent of E Sc's graduating seniors continue towards advanced degrees and have no difficulty finding placement in the top graduate schools in the country. The balance of our seniors accept positions primarily in industry and government laboratories, many with the choice among multiple offers. A survey of 66 recent ESM MS and PhD graduates (1998-2003) indicated that 11 accepted positions in academia, 11 continued towards the PhD degree and 42 accepted positions in industry (i.e., approximately 33 percent academia, 67 percent industry). It should be noted that half of the graduates joining industries had accepted positions such as Research or Research and Design Engineer. Several students indicated leadership positions such as Project Manager, Vice President and Technical Director.

To support students entering academia, Professor Lakhtakia has introduced, in collaboration with the Center for Integrated Research, Teaching and Learning, a Graduate Informal Education Seminar to prepare ESM students for academic careers.

ESM students find that, once the nature of our major is understood by employers, they are actively recruited. The critical issue is increasing the recognition of the ESM programs and communicating our value to the professional community. The Retention, Recognition and Placement Team will collaborate with the Identity and Communications Team to develop a plan to enhance the recognition of the ESM program and facilitate the placement of ESM students. The plan will foster the need for globally competitive excellence and emphasize its importance in the national interest. The plan will also include defining the target organizations that our graduates serve and constructing a marketing strategy and communications plan for those organizations.

Through research experience in faculty laboratories, E Sc undergraduate students are better prepared for graduate school and/or careers in industry

RECRUITMENT, RETENTION AND PLACEMENT ACTION PLAN

Critical Issue:

Economic and global factors are creating an uncertain climate for recruitment and retention of faculty and students.

Strategic Goal:

Develop new strategies to recruit and retain faculty, students and staff and enhance placement of ESM students.

Recruitment, Retention and Placement Team:

For Faculty	Ashok, Lenahan, Bakis, Costanzo
For Graduate Students	Rose, Tittmann, Cusumano, Lakhtakia, Urquidi-Macdonald
For Undergraduate Students	Pangborn, Pytel, Engel, Shaw, Masters, Lissenden
Staff representative	Ritter, Orr, Winkler, Croyle, Business Coordinator
IPAC member	tbd
ESM student representatives	tbd (undergraduate); tbd (graduate)

Action Items:	**Date**
Faculty	
• Develop recruitment plan for health monitoring faculty	**2005**
• Advertise health monitoring position 1	**2005-2006**
• Advertise health monitoring position 2	**2006-2007**
• Submit NSF ADVANCE proposal	**2005**
• Create plan for pursuing foundation support for faculty positions	**2005**
Students	
• Identify target undergraduate institutions and establish agreements	**2005-2007**
• Identify target high schools and enter agreements	**2005-2007**
• Design a marketing plan for bio-nano, health monitoring and mechanics	**2005-2007**
• Market IUG program	**2005-2007**
Retention	
• Establish plan for increasing quality and numbers of ESM students	**2005-2006**
• Review and recommend improvements to ESM advising experience	**2005-2007**
• Review and recommend improvements to acceptance criteria and procedures	**2005-2007**
• Identify and pursue sources of student support	**Ongoing**
Placement	
• Assess and expand Graduate Informal Education Seminar	**2005-2008**
• Collaborate with Identity and Communications Team to develop plan for industrial recognition of the value of ESM programs	**2005-2008**
• Engage IPAC and alumni in planning process	**Ongoing**

Strategic Goal 5: Enhance Our Alumni, Corporate and Foundation Relations and Development Activities to Increase Support for Key ESM Initiatives

ESM has ambitious plans for the growth of our undergraduate and graduate programs and faculty. To be successful, ESM must increase, significantly, its philanthropic, corporate and endowment support base. ESM's first priority will be to develop, in collaboration with the College of Engineering and University Division of Development and Alumni Relations, a plan for enhancing ESM's development, alumni relations and corporate relations activities. Critical to ESM's success will be engaging our constituencies in this process through the communications plan, developed by the Identity and Communications Team, which will be launched with the issue of the ESM Centennial Newsletter in 2005. High quality written and electronic communications will be developed to increase awareness of the ESM Department's reputation, accomplishments and needs.

ESM will work closely with the COE and University Alumni Relations offices to track our undergraduate and graduate students, keep our alumni database current and organize alumni reunions and events. Plans will be developed for a "Centennial Reunion" to be held in 2005, and we shall appoint a committee of our active emeriti faculty to assist us in communicating this event to our alumni.

The Development, Alumni and Corporate Relations Team will develop plans to build relationships with our key constituencies to increase their affinity and involvement with the department. These will include building our advisory boards (IPAC, CISP industry members, cNEU); fostering interactions among their members, our faculty and students; nominating members for departmental, college and University awards; hosting special events both within the University and at external venues; and personal visits by the Department Head, Center Directors and faculty to strengthen alliances with the ESM Department. These activities will help us to identify and cultivate the support base that can assist us in developing the resources for endowing priority needs such as student scholarships and awards, an ESM distinguished lecture or seminar series and chairs for distinguished faculty.

At the same time, ESM will work with the college and University to identify corporations, foundations and associations with interests matching those of the ESM Department and to develop strategies for presenting our initiatives to these foundations.

ESM is committed to diligent stewardship and being a prudent investment for the department's donors. ESM will develop a stewardship plan that includes an annual review of expenditures; development of an annual report for our donors; and enhanced communications among ESM's students, faculty and benefactors.

DEVELOPMENT AND ALUMNI RELATIONS ACTION PLAN

Critical Issue:
ESM's alumni, corporate and foundation relations activities and philanthropic support bases need to be strengthened.

Strategic Goal:
Enhance our alumni, corporate and foundation relations, development and marketing activities to increase support for key ESM initiatives.

Development, Alumni and Corporate Relations Team:

Alumni Relations and Development	Sanders, Todd, Croyle
Communications and Marketing	Sanders, Croyle, Ames
Special Events	Bierly
IPAC member	tbd
ESM faculty representatives	Fonash, German, Catchmark, Bogue
ESM student representatives	tbd (undergraduate); tbd (graduate)

Action Items:	**Date**
Planning	
• Consult College of Engineering and University Development and Alumni Relations	**2005**
• Construct ESM Development, Alumni and Corporate Relations Plan	**2005-2006**
Development, Alumni and Corporate Relations Communications	
• Distribute ESM Centennial newsletter	**2005**
• Organize Centennial alumni reunion	**2005**
• Develop alumni and corporate relations aspects of ESM web site	**2005-2007**
• Develop new ESM promotional materials	**Ongoing**
• Produce quality written and electronic communications to increase awareness of the department's reputation, accomplishments and needs	**Ongoing**
• Submit department news for inclusion in college and University written and electronic communications media	**Ongoing**
• Seek out and provide opportunities for department head, faculty, staff, and students to interact personally with constituents (campus visits, department head/faculty/student travel, etc.)	
Relationships with Key Constituencies	
• Build Advisory Boards (IPAC, CISP, cNEU)	**2005-2008**
• Create new opportunities for interactions among our alumni, corporate supporters, students and faculty	**2005-2008**
• Nominate constituencies for departmental, College and University awards	**Ongoing**
• Host special events ("meet the department head" receptions around the country, alumni reunion tours, alumni receptions at conferences, etc.)	**2005-2008**
Foundations and Philanthropic Entities	
• Identify and develop strategies for approaching entities with compatible interests	**2005-2008**
Stewardship	
• Develop Stewardship Plan	**2005-2006**
• Distribute annual report	**Annual**
• Enhance communications from students and faculty to benefactors	**Ongoing**

Strategic Goal 6: Implement New Administrative and Organizational Practices to Support ESM's Strategic Plan

The ESM Department's administrative functions and organizational practices aim to interface seamlessly with the students, faculty and staff so that all can achieve their full potential. For this to be accomplished, the ESM Department must plan to provide growth and promotion opportunities for its exceptionally talented staff and also to incorporate new technologies and updated skills into the work environment. As the University moves toward "job competencies" classification, the ESM strategic plan provides an opportune time to:

- review the current staff positions;
- determine how University-, college- and department-level administrative and organizational changes will impact ESM's future operations;
- establish staff professional development plans to enhance opportunities for professional growth and promotion;
- determine whether tasks/procedures should be improved or reengineered; and
- identify opportunities to upgrade or restructure staff positions.

Following the recent promotion of the department's lead bookkeeper to the College of Health and Human Development, a plan has been submitted to restructure the position to that of Business Coordinator. The Business Coordinator will join the Department Head and Administrative Assistant in leading ESM's economic strategic planning activities and developing budget analyses, models and forecasting that will enhance the efficiencies of ESM's operations. Appointment of the Business Coordinator will provide the ESM Administrative Assistant with release time to pursue the many new initiatives on strategic planning, marketing, communications, development and alumni, corporate and foundations relations described in this Strategic Plan, while maintaining oversight of budgetary operations.

In 2004, the University's Management Engineering Team (Office of Human Resources) conducted a review of ESM's staff duties and made recommendations regarding improvements in internal ESM work processes. These recommendations will be implemented in 2005 as part of our continuous quality assessment program. ESM information technology (IT) staff members William Ames and Bradley Long have made significant improvements to our computing operations, data storage, database management and interfacing with the University and college data warehouses. Over the next three years, ESM plans to implement workflow processes to reduce paper documentation and streamline office operations. ESM envisages a significantly expanded role for the IT database manager, particularly with respect to student recruitment, diversity and development activities and in liaising with the department's Undergraduate and Graduate Program Officers and their assistants. The ESM IT staff will

continue to develop many database innovations and web-based efficiencies that keep the ESM Department at the forefront of computer operations in the College of Engineering.

The ESM Department will also transition the telephone system to Voice-Over Internet Protocol (VOIP) as soon as this becomes available on the West Campus.

Staff Recognition Program

ESM will continue its active plan to create opportunities for staff recognition and promotion. During the last three years, Susan Croyle, Administrative Assistant; Eileen Orr, Undergraduate Assistant; and Carol Ritter, Graduate Assistant, have received the College of Engineering's Peer Review of Exceptional Performance (PREP) awards. Eileen Orr, Carol Ritter and Carol Winkler have received promotions. Elaine Sanders was appointed as Department Head Assistant on the retirement of Harriet Hostetter, and Bradley Long was appointed to the IT staff. ESM will continue to recognize outstanding performance and will assist the staff in identifying milestones towards promotion and awards.

Towards nanogears: The platinum catalyst on this gold microgear causes the gear to rotate when immersed in hydrogen peroxide. Studies to reduce the size of these gears are being conducted in the Nanofabrication Facility.

ADMINISTRATION AND ORGANIZATION ACTION PLAN

Critical Issue:

Streamlined organization and effective administration can be realized through continuous quality improvement.

Strategic Goal:

Implement new administrative and organizational practices in accordance with ESM's strategic plan.

Administration and Organization Team:

Financial and Strategic Planning	Todd, Croyle, Business Coordinator
Workflow Processes	Croyle, Business Coordinator, Winkler, Orr, Ritter, Long
IT and Web enhancement	Ames, Long
Facilities	Kralik, Hosterman
Recognition	Todd, Lakhtakia, Lissenden, Gray
IPAC member	tbd
ESM student representatives	tbd (undergraduate); tbd (graduate)

Action Items:	**Date**
Administration and Organization	
• Implement recommendations from the Management Engineering Study	**2005**
• Review office practices and identify opportunities for efficiencies	**2005-2006**
• Establish and implement professional development plans for office staff	**2005-2008**
• Appoint Business Coordinator	**2005**
• Develop and implement work flow processes in collaboration with the College and University	**2005-2007**
• Install VOIP telephone system	**2005-2006**
• Develop plans for upgrading ESM infrastructure, facilities, laboratories, equipment	**2005-2008**
• Implement new safety procedures for nano-bio science and engineering laboratories	**Ongoing**
• Review and update ESM safety practices and procedures	**Ongoing**
Staff Recognition	
• Develop and implement staff Personal Development Plans	**2005-2008**
• Develop and implement milestones towards promotion and awards	**Ongoing**
• Nominate staff for awards	**Ongoing**

THREE-YEAR STRATEGIC PLAN IMPACT

The initiatives described in the strategic plan will advance the ESM Department toward the goal of being widely recognized as one of the nation's top Engineering Science and Mechanics Departments. The plan will increase the tenure-track/tenured faculty from 29 to 32 and introduce new research areas that will lay the foundations for growing our undergraduate student body to 80 (junior and senior students) and graduate student body to 120 students. As the new faculty and ESM initiatives develop, a significant increase in research expenditures is expected. By 2008, the E Sc curriculum will incorporate: foundation courses in biological/biomedical sciences; new courses and a minor in bio-nano science and engineering; a new vision for mechanics education; an integrated undergraduate/graduate program; a new graduate course sequence and certificate program in Laser Materials Processing; new nanotechnology and utilization experiences; and enhanced short course offerings in powder metallurgy. The Center for Multiscale Wave-Materials Interaction will be fully operational with a growing academic and industrial user base and several research initiatives in place. The ESM Development, Alumni and Corporate Relations Plan will be progressing steadily towards the goal of increasing ESM's endowed support for students and faculty.

RESOURCES TO SUPPORT THREE-YEAR STRATEGIC INITIATIVES

The ESM Department has been fortunate to receive support from the Materials Research Institute, the Huck Life Sciences Institute and the College of Engineering to support partially the salaries and start-up packages for the two new bio-nano science and engineering positions. This support will enable the ESM department to provide well-equipped laboratories that support the research initiatives of all the bio-nano faculty. New revenue streams must be generated to grow the graduate student body. As our action plans indicate, such revenues could be leveraged by: the faculty teaming internally at Penn State and with external institutions to develop large, long-range research programs with high visibility; revenue generating activities such as the graduate laser-materials interactions certificate program; increased collaborations with industry; and enhanced philanthropic support.

Additional support for special initiatives, for example, the ESM Distinguished Professor Research Awards, has been made available through the P. B. Breneman Department Head Chair endowment. ESM will work closely with the College of Engineering and the University to increase our endowment and attract philanthropic support for our strategic initiatives.

THREE-YEAR RECYCLING PLAN

ESM's major investment over the next three years will be in hiring new faculty and establishing their new laboratories and research programs. Recycling funds made available to ESM from the College of Engineering will be invested in recruiting the highest caliber faculty and ensuring that they have the resources needed to be successful in their careers. In the unfortunate event of a 1 percent budget cut for each of the next three years, the ESM Financial Strategic Planning Team, comprising the Department Head, Administrative Assistant and Business Coordinator, would apply new ESM financial models to maximize economies in our operations. Budget cuts beyond these economies may result in a delay in hiring the health monitoring faculty.

The E Sc graduating class with department head Judith Todd at the 2004 ESM Graduation Tea Ceremony