

White Paper No. 1

MEETING THE NEEDS OF A GROWING COMMUNITY
ASMEs Future Role in Graduate Education

Graduate Student Task Force
ASME International

Task Force Membership

Adnan Akay
Richard C. Benson
John Cipolla
Francis A. Kulacki, Chair
Walter Laity
Walter F. O'Brien
George P. Peterson
Robert Warrington
Thomas Perry

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EXECUTIVE SUMMARY

The Task Force has scratched the surface of a complex issue that faces ASME and the mechanical engineering profession. Graduate students are a growing segment of the US mechanical engineering student population but generally exhibit little loyalty to ASME and a low participation rate in the Society's activities.

The primary factors for this assessment are the rapidly expanding technical and scientific horizons of modern mechanical engineering and the challenge ASME faces in offering greater value than at present to graduate students. Journals and other technical publications of the Society are generally seen as valuable to graduate students, but as one respondent to a limited environmental scan put it, there appears to be no other compelling reason for graduate students to join ASME.

When combined with potential future members from the Pacific Rim and South/Southeast Asia, the task force suggests that ASME can justify expending resources in the near term for this population of young, past-baccalaureate engineers. A combination of program development and marketing will be necessary parts of a comprehensive strategy. Whatever strategy is adopted, it must be sustained over several generations of graduate students and supported as a part of the long-term agenda of the Education Center.

For 2007 – 2008, the task force recommends:

- The task force be formalized within the Education Center and given a two-year project to develop achievable goals and objectives with respect to the graduate student community.
- A more comprehensive survey of graduate students and mechanical engineering departments be conducted to ascertain the kinds of needs that should be addressed.
- A focal point workshop should be organized at the 2007 and 2008 IMECEs to build awareness of the graduate student population and its needs. Follow up focal workshops should also be considered for other ASME events, such as the Mechanical Engineering Education Conference.
- A focal study should be conducted through the Education Center to frame the body of knowledge required of the next generation of mechanical engineering schools and educators.
- The Education Center should begin work in fiscal year 2007 on structuring fees and other costs of membership to graduate students so as to increase their involvement, at least, within the technical affairs of the Society.
- A top level sub-committee of the Education Center should be convened to plan a strategy that will build ASME's identity and image within the graduate student population.

1. Charge to the Task Force

Develop a white paper on the question, “What should ASME be doing for graduate students and graduate education in mechanical engineering?”

This white paper is intended to serve as the starting point for program and policy formation to address the needs of this population within the mechanical engineering community.

2. Definition

For purposes of the work of the Task Force, we define a *graduate student* in mechanical engineering as either a full time or a part time enrolled student in an academic program leading to either the Master of Science, the Master of Mechanical Engineering Degree, or the Ph.D. in mechanical engineering.

3. The Framework

The graduate student community in mechanical engineering, as well as the field itself, is being influenced by several major forces or framework shifts: a growing population of US graduate students in mechanical engineering, an aging US-based ASME membership, and a widened mechanical engineering knowledge base and its use in practice. Each of these forces will condition the manner in which ASME will address the future needs of graduate students.

Graduate students: a growing community

Graduate studies in mechanical engineering continue to experience growth, especially at the master’s degree level. This trend implies that the number of mechanical engineering students in graduate school present the Society with an opportunity and a challenge with respect to membership development and program offerings.

In 2004, the most recent year for which data are available¹, total US enrolment in mechanical engineering programs was 100,900, with a total graduate enrollment of 20,400 (~20%). Of full time students, some 15.4% were in graduate school. In 2004 a total of 19,500 mechanical engineering degrees were awarded, with 27 percent of them being graduate degrees. A little more than one in every four degrees awarded in mechanical engineering are graduate degrees in 2004, and based on current enrolment trends, this ratio will narrow in the near term.

¹ Sources: ASEE and NSF. (See Appendix D.)

Graduate students thus represent a growing community of post baccalaureate mechanical engineers who may have professional and technical needs that distinguish them from MEs in industry, government, and private practice.

The over arching issue is, how can ASME serve the needs of graduate students in mechanical engineering through its services and programs? Within the response the society might develop to address these issues are the setting of goals, objectives, and operational strategies.

ASME Membership

ASME membership is aging overall, with a significant decline in members who are considered to be in their immediate post-college years. These former student members and other recent college graduates are unlikely to take part in section affairs and to seek service roles on national committees. To some extent, graduate students participate in the technical affairs of the society via presentations specialist conferences and publication in the Transactions.

Input received from selected department heads, deans, and faculty members via an informal survey indicates low participation rate of graduate students in ASME programs and activities, at either the local or the national level. A variety of circumstances and reasons appear to be the cause of this current situation, but a general consensus seems to be that ASME membership is not seen as relevant to this community of mechanical engineers.

One consequence of the current situation is that ASME is not attracting a sufficient number of new and former student members from this cohort. While graduate students are a fraction of the total degreed engineers available to ASME, they represent a sizeable population of highly skilled engineers who would benefit from ASME membership and who likely would take leadership positions in the technical divisions and emergent communities of interest.

At issue is the development of new memberships, the retention of former student members, and growing a sense of professional loyalty to ASME among mechanical engineering graduate students. The operational strategies and outreach efforts to this community are key to successfully address each of these component sub-issues.

The changing nature of mechanical engineering

Mechanical engineering is a rapidly changing segment of the engineering profession. Its foundations (mechanics and thermodynamics) that admirably addressed the needs of 20th Century industries, have given way to a broader and wider set of defining sub-specialties that involve the conjunction of physical science, biology, and analysis.

Mechanical engineers are now confronted with problem solving and design for system scales that range from the molecular to the macro-levels. What mechanical engineers need to know nowadays is more centered on the application of science (often new science) than on rules of practice and transmitted experience.² This paradigm shift appears to be permanent and has implications for the professional interests and loyalties of the current generation of graduate students, as well as the kind of educational programs that evolve from this reality. In short the *body of knowledge* required for the successful practice of mechanical engineering has begun to change dramatically as the 21st Century begins.

At issue is how the Society can shape its programs and services to remain a technical focus for mechanical engineers who see ever widening technical and professional horizons, especially those who are graduate school? Concurrently, what can ASME do in concert with the engineering schools to develop the graduate programs needed by the next generation of mechanical engineers?

Implications for ASME

Given the population dynamics within the mechanical engineering educational sector, trends in ASME membership, and the evolving mechanical engineering field, the Society is presented with a rich set of challenges and opportunities that require a keen sense of its external environment, as well as innovative organizational strategies aimed at graduate students in mechanical engineering.

4. Environmental Scan

In the preparation of this white paper, an informal survey of a selected cross section of the mechanical engineering education community was taken to get an initial sense of its understanding of the issues facing both graduate students and ASME. This survey does not encompass the entire mechanical engineering graduate community and is therefore intended to provide a snapshot of the situation Society faces as it begins to address the needs of graduate students. A summary of the responses received is presented in this section, and the individual responses without attribution are contained in Appendix C.

What is the credibility in general of ASME to both graduate students and mechanical engineering community?

There is a mixed response on the credibility of ASME, but the center of gravity of opinion is that the Society does not have uniformly high credibility as a professional organization within the mechanical engineering graduate student population. The value

² Laity, W., et al, 2004, "A Vision of the Future of Mechanical Engineering Education, ASME, New York; also, Vincenti, W.G., 1990, *What Engineers Know and How they Know It*, John Hopkins University Press, Baltimore.

of the Society to graduate students and to some extent the mechanical engineering community at large was seen as questionable with no compelling reason for membership.

Does the average graduate student identify ASME as his/her professional society?

ASME appears to have an identity problem with the current generation of graduate students owing to the appeal of other professional and scientific societies that are more closely identified with their research sub-specialties. The underlying theme within the responses received is that mechanical engineering graduate students are attracted to many professional societies and technical/scientific organizations, including ASME, if they are at all involved with such organizations. Student choice seems to rule in this area based on current interests.

Are graduate students today more, or less, likely to join any professional society either while in school or when they begin their careers?

A wide range of opinions is expressed on this question, and a much wider survey would be needed to gauge the potential for interest in ASME membership within the graduate student population. However, respondents see membership for graduate students as something that is put on hold, or at least selectively chosen, when the student is in school.

Are professional and technical societies seen as important, in general, by our graduate students?

Responses to this question reinforce those of the previous two questions but exhibit a range from “absolutely yes” to “no”. A much wider survey would be needed to determine the center of opinion within the national graduate student community.

What are the needs of graduate students in mechanical engineering that ASME appears able to address immediately?

Responses to this question were largely constructive and contained several valuable action-oriented ideas, such as, involvement with career planning, networking, and conference fees conducive to graduate student attendance at specialty conferences

What are the long-term needs of graduate students in mechanical engineering that ASME should be addressing?

Few constructive ideas are offered in response to this question other than the linking of graduate students to the emerging communities of knowledge and practice within ASME.

What strategies and tactics should ASME use to address immediate and long-term needs of graduate students?

Responses to this question revealed several strategies ranging from intensified public relations and marketing to graduate students to increased support for graduate student attendance at ASME conferences. All of them, others that may emerge from additional surveys and internally generated strategies should be discussed by the successor to the task force and the Education Center.

5. Conclusion and Recommendations

The Task Force has scratched the surface of a complex issue that faces ASME and the mechanical engineering profession. While graduate students represent a growing fraction of all mechanical engineering students, their low participation rate via either membership or personal involvement in ASME is generally acknowledged. A variety of reasons are offered to explain this state of affairs via a limited environmental scan conducted for the purpose of this white paper. Chief among them appear to be rapidly expanding technical and scientific horizons of modern mechanical engineering, i.e., a rapidly changing body of knowledge that for graduate education and practice. Additionally, ASME faces a challenge in offering greater value than at present to graduate students as a compelling reason for them to either maintain or initiate membership.

The current US graduate student population represents a significant number of potential members. When combined with potential future members from the Pacific Rim and South/Southeast Asia, the Society can justify expending resources in the near term for this population of young, past-baccalaureate engineers. A combination of program development and marketing activities will be necessary parts of a comprehensive strategy. Whatever strategy is adopted, it must be sustained over several generations of graduate students and supported as a part of the long-term agenda of the Education Center.

Based on the responses received from the environmental scan, operational strategies that the Society might pursue are not apparent and require extended development via a successor task force and sustained attention of the Education Center.

Based on our initial look at the mechanical engineering graduate student community and ASME's relation to, the task force recommends that in the coming fiscal year, the following action be taken:

- The task force should be formalized within the Education Center and given a two-year project to develop achievable goals and objectives with respect to the graduate student community.

- Resources for task force work and attendance at key meetings (IMECE and SAM) should be made available. A reasonable level of ASME staff support would be required as well.
- A more comprehensive survey of graduate students and mechanical engineering departments be conducted to ascertain the kinds of needs that should be addressed. Such a survey will require staff support and some financial resources. We suggest that the ASME Foundation be approached for a grant to support this survey.
- A focal study should be conducted through the Education Center to frame the body of knowledge required of the next generation of mechanical engineering schools and educators.
- Focal workshop should be organized at the 2007 and 2008 IMECEs to build awareness of the graduate student population and its needs. The location of the 2007 IMECE in Seattle would be an attractor to participants from the Pacific Rim countries, and possibly India. Follow up focal workshops should also be considered for other ASME events, such as, the Mechanical Engineering Education Conference and workshops at the 2007 and 2008 SAM.
- The Education Center should begin work in fiscal year 2007 on structuring fees and other costs of membership to graduate students so as to increase their involvement, at least, within the technical affairs of the Society.
- A top level sub-committee of the Education Center should be convened to plan a strategy that will build ASME's identity and image within the graduate student population.

Appendix A. Task Force Membership

Member	Contact Information
Adnan Akay Dept. of Mechanical Engrg. Carnegie-Mellon University Scaife Hall 401 5000 Forbes Ave. Pittsburgh, PA 15213	T: 540-231-9752 F: 412-268-3348 E: akay@andrew.cmu.edu
Richard Benson Office of the Dean College of Engineering 333 Norris Hall Virginia Tech Blacksburg, VA 24061	W: 540-231-9752 F: 540-231-3031 E: deaneng@vt.edu
John W. Cipolla Dept. of Mechanical Engrg. Northeastern University 334 Snell Engineering Boson, MA 02115	T: 617-373-3807 F: 617-373-2921 E: jwc@coe.new.edu
Francis A. Kulacki Dept. of Mechanical Engrg. University of Minnesota 111 Church St. S.E. Minneapolis, MN 55455	T: 612-625-3807 F: 612-624-5230 E: kulacki@me.umn.edu
Walter Laity Pacific Northwest Laboratories P.O. Box 999 Richland, WA 99352	W: 509-372-3307 F: 509-539-3270 H: 709-375-1316 E: walter.laity@pnl.gov
Walter F. Obrien Dept. of Mechanical Engrg. 109 Randolph Hall Virginia Tech Blacksburg, VA 24061	W: 540-642-6450 F: 540-231-9100 E: walto@vt.edu
George P. Peterson Office of the Provost Rensselaer Polytechnic Inst. 110 Eight Street Troy, NY 12180 (MANE Dept., 5214 JEC)	T: 518-276-2390 E: peterston@rpi.edu
Robert Warrington Office of the Dean College of Engineering Michigan Technological Univ. 1400 Townsend Drive, Room 712 Houghton, MI 49931-1295	W: 906-487-2782 F: 906-487-2782 E: row@mtu.edu
Thomas Perry ASME International Three Park Ave. New Your, NY 10016-5990	T: 212-591-7234 F: 212-591-7143 E: perryt@asme.org

Appendix B. Input from the Mechanical Engineering Education Community

Selected mechanical engineering department heads, deans and faculty members (Appendix C) were contacted for informal input on several questions that define the framework for ASME's long-term approach to the ME graduate student community. A brief questionnaire was sent to each individual via e-mail with a request to provide short, "first cut" comments on eight items that form the large framework of the work the task force.

Responses from 12 individuals were received, and some did not comment on all items in the questionnaire. Responses are summarized here without attribution to provide a record for further discussions, priority setting, and action of the Task Force and the Education Center.

1. What is the credibility in general of ASME to both graduate students and mechanical engineering community?

Mixed, reasonable but not high with graduate students. Although we are less knowledgeable about the attitude of the "community at large" we suspect it is similar. I think the membership trends in ASME speak to this.

High. I am most familiar with AMD and I think it is very highly thought of.

Low: For students involved in fluid dynamics, the premier organization is the American Physical Society-Division of Fluid Dynamics. ASME is peripheral. Part of the problem is expensive registration for meetings that are not focused.

I cannot speak on behalf of the engineering community at large. I have, however, spoken to many faculty members, including those from our department and ones from outside. I believe the prevailing view is that ASME provides a valuable forum for faculty to interact with their colleagues. However, I have also gotten the strong message that the ASME organization is inefficient, unresponsive and bureaucratic. I believe that other professional organizations serve their members much better.

ME graduate students seem not so familiar with ASME. The faculty is generally positive toward ASME.

On our campus, ASME is seen as an undergraduate activity or something for the faculty to be involved with, and has very limited appeal to the Graduate students. The credibility of ASME in the ME community is very uneven. Some ME's belong and are active, while others see no compelling reason to join.

About the same as most professional organizations: some people think it's great, some people think it's a joke, some are neutral.

Satisfactory,

I believe it is good.

Perceived value to graduate students is low. Why should they join and what is the value received for membership? These are the main questions that must be asked.

2. Does the average graduate student identify ASME as his/her professional society?

Maybe. Certainly some do identify with ASME. However, many identify with other specialty associations more closely identified with their area of research specialty such as SME, ASA, The Physical Society, IEEE, SAE, ASHRAE, etc.

Average - yes. IEEE is another area of focus (robotics types).

My students tend to join both ASME and APS, if they are studying fluid dynamics.

In some areas the answer is YES, but in other sub fields like "fire and combustion" the answer is likely NO.

It seems that the graduate students are not so interested in professional societies, including ASME. It seems that we do not make an effort to attract them to our student chapter, which is virtually all undergraduate.

Not actively. Some choose the smaller, more focused professional societies - ASHRAE, SAE, SEM, IMAPS,... as the vehicle for increasing their professionalism in their chosen area of specialization (often the dissertation work).

Yes.

Not always. It depends on their research topic.

ASME has an identity problem with graduate students.

3. Are graduate students today more, or less, likely to join any professional society either while in school or when they begin their careers?

Not sure what you are comparing to - than when they were students or in the past. Can't really say.

My impression is that students tend to see membership as only minor importance to professional success. Much more important is publications.

Maybe less (but I don't have any real feel for it). Could be related to changes in networking in society - internet, linkedin,...

I believe they are FAR MORE LIKELY to join and be VERY ACTIVE in professional organizations. Many professional organizations actively encourage graduate students to participate, and graduate students are far more likely to attend meetings regularly and to give presentations than was the case when I was a graduate student. For example, I attended one professional meeting as a graduate student, where I gave a lecture. My students give talks at such meetings once or twice each year. I believe this pattern is typical.

I don't think the US graduate students are less likely to join than in the past, but the international students have not usually been exposed to ASME (or other ME society) in their countries of origin and take several years to even understand what ASME is all about, let alone think about joining. Moreover, since the work place appears to be less supportive of society membership and active participation than in the past, many years will go by before they "accidentally" discover ASME and think about joining. During this "hiatus" many have moved out of day-to-day engineering and/or become involved in another professional organization that is more directly focused on their "product" or industry and are lost to ASME.

They are more likely to join a professional society that caters to their specialty.

Graduate students seem likely to join a professional society only when they begin a career in academia. Those going to industry seem less inclined to join a professional society.

No idea. I joined SIAM when I was a grad student, and my grad students tend to join. I don't know the trends.

Not many join, [but I] don't know how it compares to the past.

About the same.

4. Are professional and technical societies seen as important, in general, by our graduate students?

Yes, in terms of published research material, but less so with respect to career building, and professional services.

Yes. [two responses.]

ABSOLUTELY.

No.

Probably not, but I really don't know.

Not while in school.

For those going after an academic profession. Less so for others

5. What are the needs of graduate students in mechanical engineering that ASME appears able to address immediately?

ASME must become contemporary to attract graduate student members and participation. Feeling expressed that ASME needs to become for involved with the contemporary issues in mechanical engineering and issues facing graduate students.

Networking, venues to present technical contributions.

Not sure on the immediacy part.

Graduate students need a forum for presenting their research findings that allows them to present papers as colleagues of faculty, rather than students. A case in point is the American Physical Society Division of Fluid Dynamics. At that meeting 40% of the registrants were graduate students, most of whom presented papers at the same sessions as faculty. Part of the reason this is possible is that the registration fees are reasonable for students (\$145 advance registration) and faculty (\$300 advance registration), so that both the professor and the student can afford to attend the meeting. In addition, the talks are short and individuals are limited to one talk per person. As a result of this structure, a more collegial atmosphere results between students and faculty attending the meeting.

Faculty whose interests are better met by ASME would need to answer this question. Students that I interact with, for the most part, are not served well by ASME, although there has been some interest in the recent nanotechnology meetings.

Publications and presentation of their work.

Not clear that the graduate students perceive any needs that can be addressed by ASME.

Locally: networking, US socialization and business practices (for international students). Nationally: technical knowledge base, technical role models and mentors, exposure to new concepts, tools, technologies.

Connections to employment when they graduate. Education about the profession.

Don't know. (Raising fellowships?)

Help with academic careers

6. What are the long-term needs of graduate students in mechanical engineering that ASME should be addressing?

No obvious suggestions.

Recognition of the changing sphere of ME - bioengineering, nanotechnology, modern energy issues. Aligning some society focus on these areas and others that will emerge.

Recognition of the changing sphere of ME - bioengineering, nanotechnology, modern energy issues. Aligning some society focus on these areas and others that will emerge.

Be at the forefront of emerging areas for our discipline; enable graduate students to participate meaningfully; encourage graduate students to present lectures on their work; professional development education; [and] provide meaningful contacts between graduate students and leaders.

Jobs and career advancement.

Not clear.

Exposure to professional practice.

Strong connection to the "communities of practice (knowledge)" for peer learning - conferences, workshops, journals, mentoring

How to cope in a society that is outsourcing a great deal of what mechanical engineers have typically done.

Continuing education.

Identification of future research agenda of national concern and priority.

7. What strategies and tactics should ASME use to address immediate and long-term needs of graduate students?

Funding opportunities to help support getting a graduate education. Fellowships, teaching grants etc.

Be at the forefront of emerging areas for our discipline; enable graduate students to participate meaningfully; encourage graduate students to present lectures on their work; professional development education; provide meaningful contacts between graduate students and leaders. (Repeated response as for Question 5 above.)

ASME needs to become a premier society in the "sub disciplines" of ME & needs to have bigger audience.

Don't know.

With professional practice - and innovation - shifting to graduate degree holders, it appears appropriate to shift traditional ASME student section activities "upward" to graduate students. It would be good to emulate the procedures of the Business Schools which foster networking and job hunting, while providing career counseling and mentoring, almost from the first day on campus of their MBA students. With the more extensive technical background of the graduate students, design, patent, and business plan competitions, as well as build and test competitions, could be held at much higher technical levels.

ASME must raise the value in itself in the view of companies and by the government. The Society has to become [more] influential in both communities.

ASME could use the IEEE or APS model [for involvement and attraction of graduate students]. It seems that IEEE and APS members feel that they are not connected if they are not involved with their respective societies.

The Society must “glorify” mechanical engineering to provide an attractor to graduate student membership and participation. This is an internal challenge that must be taken up by ASME.

ASME must seek connectivity with the graduate student population once glorification is underway.

A professional framework needs be developed by ASME [for graduate students and membership in general].

Have the ASME industrial advisory board provide, say, \$5,000 each year from their companies to support the attendance of graduate students in the IMECE [and other conferences]. Such a strategy would work if schools would match a dollar amount for students to attend the conferences/

8. Please comment on issues or needs in relation to graduate students and graduate education that you feel ASME should be addressing as it moves forward over the next decade. Would you be willing to contribute to initiatives that address these needs either at the local, regional, or national level?

No good ideas except the following. ASME might consider organizing something like the "Face Book" that is on the web for ME graduate students to help them network. Also make ASME journals available online free to graduate students to encourage them to use and become connected to ASME publications.

[F]ocus on the ever-evolving field of Mechanical Engineering, from nano to bio to eco/energy.

I attended several ASME meetings and attended sessions that, I believed, could conceivably be pertinent to my interests. I came to realize that if ASME were to be a worthwhile forum for me, I would need to organize new programs. Since my needs are being met well by other organizations and because I only have enough time to attend a fraction of those meetings, I decided not to get further involved with ASME.

I feel that quality is being compromised for quantity. We need to clearly separate a professional MS degree where "quantity" is appropriate from a Ph.D. degree that should emphasize "quality". I would be willing to speak with you about this.

As stated above, the graduate student needs and issues that ASME can address are not apparent.

It is laudable that ASME is trying to identify graduate students needs that could be addressed by the society. Certainly ASME should take some new initiatives aimed at graduate students. These initiatives should not necessarily be in response to needs.

I'd be happy to participate in such initiatives.

I think that Masters [students] in general would have very similar views of the ASME [compared] to Bachelor degree recipients. PhDs going into the Gas Turbine industry would be quite likely to get involved through the Gas Turbine Institute. PhDs going into academia often see the ASME as somewhat helpful in getting tenure. Some of these people put in quite a bit of effort for the society, but most are takers rather than givers in the early stages of their careers because of the pressures associated with getting tenure. I am not very familiar with other career paths for PhDs.

Appendix C. Contacts with Mechanical Engineering Educators for Environmental Scan

Dennis Assanis, Chair
Dept. of Mechanical Engineering
University of Michigan
2250 G. C. Brown
2350 Hayward
Ann Arbor, Michigan 48109-2124
assanis@umich.edu

E. Daniel Hirleman, Head
School of Mechanical Engineering
Purdue University
585 Purdue Mall
West Lafayette, IN 47907-2088
e.daniel.hirleman.1@purdue.edu

Klod Kokini
College of Engineering
Purdue University
West Lafayette, IN 47907-2088
kokini@purdue.edu

Kirshnaswamy Srinivasan
Dept. of Mechanical Engineering
The Ohio State University
650 Ackerman Rd., Suite 255
Columbus, OH 43202
Srinivasan.3@osu.edu

Huseyin Sehitoglu
Mechanical and Industrial
Engineering Department
University of Illinois
148 MEC
1206 West Green Street
Urbana, Illinois 61801-2906
huseyin.@uiuc.edu

Brian Moran
Dept. of Mechanical Engineering
2145 Sheridan Rd., Rm. A332
Evanston, Illinois 60208-3111
b-moran@northwestern.edu

Peter H. McMurry, Head
Dept. of Mechanical Engineering
University of Minnesota
Minneapolis, MN 55455
mcmurry@me.umn.edu

Dr. Joseph H. Beaman, Jr.
Mechanical Engineering Dept.
The University of Texas at Austin
1 University Station C2200
Austin, TX 78712-0292
jbeaman@mail.utexas.edu

Dr. Ward O. Winer, Chair
Woodruff School of Mechanical
Engineering
Georgia Institute of Technology
Atlanta, GA 30332-0405
ward.winer@me.gatech.edu

Dr Glenn Sinclair
Dept. of Mechanical Engineering
Louisiana State University
2508B CEBA Building
E-mail: sinclair@me.lsu.edu

Dr. Mark Tuttle, Chair
Dept. of Mechanical Engineering
University of Washington
Seattle, WA
tuttle@u.washington.edu

H. Joseph Summer III
Dept. of Mechanical and Nuclear
Engineering
Penn State University
137 Reber Bldg.
University Park, PA 16802
hjs1@psu.edu

Judith A. Todd, Head
Department of Engineering Science
and Mechanics
Penn State University
212 Earth-Engrg. Science Bldg.
University Park, PA 16802
hjs1@psu.edu

Vijay Dhir, Dean
College of Engineering and
Applied Science
UCLA
vdhir@seas.cucle.edu

Thomas Hahn, Chair
Mechanical & Aerospace
Engineering
Henry Samueli School of
Engineering and Applied Science
UCLA
48-121 Engineering IV
420 Westwood Plaza
Los Angeles, CA 90095-1597
hahn@seas.ucla.edu

Allan T. Kirkpartick
Department of Mechanical
Engineering
Colorado State University
Fort Collins, CO 80523
allan@engr.colostate.edu

Keith Rouch
Department of Mechanical
Engineering
University of Kentucky
152 Ralph G. Anderson Building
Lexington, KY 40506-0503

Richard Gould
Department of Mechanical and
Aerospace Engineering
North Carolina State University
Rayleigh, NC
gould@eos.ncsu.edu

Avram Bar-Cohen, Chair
Department of Mechanical
Engineering
University of Maryland
2181 Glenn L. Martin Hall
College Park, MD 20742
abc@umd.edu

Rohan C. Abeyaratne
Department of Mechanical
Engineering
MIT
Cambridge, MA
rohan@mit.edu

Stephen Malkin
University of Massachusetts
Engineering Lab 220 A
Amherst, MA
malkin@ecs.umass.edu

Belinda A. Batten
Department of Mechanical
Engineering
Oregon State University
Rogers 208
Corvallis, OR 97312
bbatten@engr.orst.edu

Frederic B. Prinz
Department of Mechanical
Engineering
Stanford University
Palo Alto, CA
mechair@me.stanford.edu

Jean-Jaques Chattot, Chair
Mechanical and Aeronautical
Engineering
University of California
One Shields Avenu
Davis, CA 95616
jjchattot@ucdavis.edu

Viswanath Prasad
College of Engineering and
Computing
Florida International University
10555 W. Flagler Street
Miami, FL 33174
Vish.Prasad@fiu.edu

Ronald Bennett, Dean
School of Engineering
University of St. Thomas
OSS 106
2115 Summit Ave.
St. Paul, MN 55105
rjbennett@stthomas.edu

Appendix D. Mechanical Engineering Enrollments 1985-2004

Degrees granted and enrolment in mechanical engineering from for two periods from 1985-2004 are summarized in the tables below. These periods have been chosen because they represent opposite trends for engineering as a whole and demonstrate that mechanical engineering tends to claim a steady percentage of the degrees granted and overall enrollment. From the 85/86 to 93/94 academic years, baccalaureate degrees for all fields fell form a high of 78,000 to 65,000. However, by 2004, baccalaureate degrees rebounded to 73,000 with the average over the five year period being 66,700, about four percent below the average of the previous period.

Engineering undergraduate enrolments for the 1999 – 2004 period increased about 13 percent with an average of 358,000 very similar to that of the 1988-1994 period.

While overall engineering enrollments have risen and fallen over this period, the percentage of students enrolled in mechanical engineering programs has remained a relatively constant percentage of baccalaureate enrolment.

Table D.1. Average degrees awarded annually for two periods. (Sources: NSF, ASEE)

	1985-1994	1999-2004
	(Percent of B.S. Degrees)	
B.S. Degrees/yr (All Fields)	69,557	66,735
M.S. Degree/yr (All Fields)	25,120 (22.4)	32,791 (49.1)
Ph.D. Degree/yr (All Fields)	5,055 (7.7)	5,132 (7.7)
B.S.M.E. Degrees/yr	15,580 (23.7)	13,289 (19.9)
M.S.M.E. Degrees/yr	3,870 (5.6)	3,668 (5.5)
Ph.D. M.E. Degrees/yr	821 (1.2)	830 (1.2)

Table D.2. Engineering enrollment for 1999-2004. (Sources: NSF, ASEE.)

Average annual undergraduate Enrollment (all fields)	358,076
Average annual enrollment in MS programs (all fields)	82,346
Average annual enrollment in	

Ph.D. Programs (all fields)	45,806
Average annual B.S.M.E. enrollment (full time)	70,711
Average annual M.S.ME. enrollment (full and part time)	11,248
Average annual Ph.D. enrolment (full and part time)	6,198