

ME Department Plan to Reach Top-20 Status

July 1, 2003

1. Departmental Overview

In this section the perceived strengths, weaknesses, opportunities, and threats (SWOT) for the department are reviewed. The assessment is based on a comparison with data for the top-20 schools. This comparison is succinctly given in Table 1.1.

1.1 Strengths

The department has a number of strengths including a large undergraduate student body in the ME program and sizable graduate enrollment. The CAVE center is strongly linked with the ME program and is a source of considerable research funding. The Transportation Peak is heavily invested in ME and provides faculty positions and infrastructure to support an active and focused research effort. The ME department has many outstanding faculty who are excellent in teaching and research. We also have a tremendous number of alumni-many with distinguished careers and considerable ability to contribute money, influence, and expertise to the department. The Totty endowment allows investment in improved teaching resources and student projects and has had a major impact on the strength of the department. The Wilmore renovation has provided some excellent and much needed research space. By its nature mechanical engineering is a broad and stable field and as a result no one industry can have a dramatic influence on the department. The areas of interest for mechanical engineers positions us to be in the forefront in new technology development for this century including nano technology, biomedical, and transportation research. Mechanical engineering will likely become the leading engineering discipline in “high tech” areas in the next 25 years.

1.2 Weaknesses

The department does have some tenured faculty who do not contribute at a level necessary to arrive at top-20 status. We are sorely lacking in funding in a number of ways to be described in detail subsequently.

Table 1.1. Benchmark Data with Top-20 ME Departments

APPENDIX A

Benchmark Data for the Top-20 Mechanical Engineering Departments

Ranking	school	# ME undergrads	# university students total	# ME enrolled in MS	# ME enrolled in PhD	# students enrolled grad sch in univ	# ME BS degrees	# ME MS degrees	# ME PhD degrees	ME \$ res exp x 10**6	# ME NAE faculty	# ME faculty	# ME fellowship	# ME GTA's	# ME GRA's	Notes
1	MIT	269	4178	172	178	6139	92	97	33	24.3	3	58	91	27	261	
2	U of Michigan	499	24472	210	218	11228	250	114	37	23.1		54	43	27	261	
3	U of Cal-Berkley	419	23835	78	235	9310	124	50	48	14.6	2	45	48	58	239	
4	Stanford	110	6637	200	112	7536	46	129	32	23.3	6	33				
5	U of Illinois	730	28243	110	151	8966	160	51	14	9.1		46	18	42	150	me+ ind
6	Ga Tech	1105	11479	223	236	5020	245	140	19	29.7	1	66	141	55	288	
7	Purdue	734	30908	127	202	6757	212	72	20	46.6	1	51	48	65	221	
8	Cal Tech		939	16	39	1210		12	5			10				
9	U of Minnesota	683	28103	132	95	11987	152	53	15		3	39	15	57	105	
10	Cornell	321	13725	56	67	4288	126	38	1	3.6	2	24	14	28	57	me+ae
11	U of Texas	701	39661	205	167	10879	188	38	15	5.5	1	54	63	63	103	
12	Princeton	103	4636			1975	34	7	7	7.7		24				me+ae
13	Carnegie Mellon	276	5418	36	39	4122	76	13	5	2.5		21	3	17	36	
14	Penn State	690	61029	72	78	10646	225	40	12	15.8		43	43	40	88	
15	U of Wisconsin	471	28677	74	87	8822	156	30	17	10.7		30	8	18	51	
16	Northwestern	101	9221	6	94	6582	35	12	9		5	23	81	26	193	
17	U of Cal-S. Diego	576	19088	46	85	3311	57	14	7	8.7	2		14	19	51	me+ae
18	Ohio State	943	43993	58	111	10219	126	42	22	6.8		42	23	19	76	
19	Renasselaer Poly	441	5080	37	89	1633	126	34	20	2.7	1	39	3	46	49	me+ae
20	Texas A&M	1048	36773	259	103	7815	195	75	14	20.2		47	18	42	133	
21	Va Tech	683	21473	110	39	6194	220	43	8	5.1		34	55	40	80	me+ae
22	North Carolina St	722	20146	74	34	5847	157	20	8	6.6		37	17	33	63	
	auburn	420	19603	41	44	2930	83	7	4	1.4		25		26	73	me+mtl
	avg top 20	537.8	21305	111	126	6922	138	53	18	16.9	1.42	39	45	43	157	

Our space is substandard, inadequate, and scattered, which hampers our ability to attract outstanding funding. The number of faculty and research positions is not adequate to achieve top-20 status. Our numbers and quality of PhD students (particularly American) are inadequate and the current reputation of the College (and Department) makes it difficult to overcome this deficiency. The proliferation of Mechanical Engineering departments within the state and the subsequent dilution of support substantially reduce our ability to achieve top-20 status.

Probably our greatest weakness is the lack a major research center associated with the department that has large research expenditures and a number of high-level, staff positions (an example of what is needed is NCAT).

1.3 Opportunities

We are very fortunate to have a number of exciting opportunities available. As noted above we can be in the forefront of new “high tech” advances in nano-technology and biomedical engineering. We are situated near Huntsville (the high tech area in Alabama) and have excellent contacts that should provide us with mechanisms to take advantage of our expertise. In the near term we have some special opportunities to move ahead in the transportation arena including development of a national rollover test facility and an automotive research center in conjunction with Hyundai. Since mechanical engineering is a “steady” discipline we have a continued opportunity to educate undergraduate and graduate students in the discipline and to expand the numbers and quality of these students.

1.4 Threats

The biggest threat to our department is the possibility of insufficient funding support for the program. Also, paradoxically if economic conditions improve, the ability to attract top notched graduate students will become much more difficult.

1.5 Summary

The following information represents summary goals that we feel are needed to achieve top-20 status based on the SWAT analysis above and a comparison with top-20 departments. These goals are categorized as “programmatic” and “support”. Programmatic goals are overall metrics that the department must achieve in order to reach top-20 status. Support

goals are those results that must be accomplished in order to achieve programmatic goals.

Support Goals

1. *Add one faculty member with NAE membership or ability to be inducted into the NAE*
2. *Add 5 Junior level faculty with at least 3 from top-10 schools*
3. *Add 30,000 square feet of new space and consolidate existing space*
4. *Obtain at least 2 million dollars of funding for special research equipment*
5. *Provide 20 scholarships valued at full tuition for entering, high-quality undergraduates*
6. *Establish 20 graduate fellowships valued at \$20,000 annually*
7. *Maintain 25 GTA's and 50 GRA's at a value of \$1,600 per month*
8. *Develop a staff infrastructure to support the graduate program envisioned*

Programmatic Goals

9. *Improve the quality of the undergraduate program*
10. *Increase Masters student enrollment to 50 students with a graduation rate of 20 to 30 students per year*
11. *Increase PhD student enrollment to 50 students with a graduation rate of 20 to 30 students per year*
12. *Reach and maintain a faculty level of 25 faculty with approximately equal distribution of Assistant, Associate and Full Professors.*
13. *Maintain an annual research expenditure of \$250,000 per faculty member*
14. *Maintain a total of approximately 40 scholarships for undergraduates*

Note: Goals 5,6,7,8 are programmatic goals as well as support goals.

A detailed explanation of these goals and their rationale follows in Sections 3 and 4.

2. Future Research Focus Areas

A succinct summary of our proposed research focus areas follows. The research focus areas are given in three categories: 1. research focus areas that are well underway and a national reputation is emerging, 2. research focus areas that are developed to a point where a significant national

reputation already exists, and 3. those areas that are very important but the department is not significantly pursuing at present. The faculty chooses to emphasize peak areas since significant faculty strength and infrastructure are already available. All of the peak areas are “hot topics” with significant research funding opportunity over a significant period. Also, these topics can provide significant visibility.

2.1 Research areas under development

We seek to develop a national reputation for research in the areas of Transportation and Information Technology. Specifically these areas will include: mechanical and thermal packaging of electronics such as those found in automotive and wireless applications, vehicle dynamics and crash worthiness, autonomous vehicles (particularly military and off-road applications), noise control, manufacturing automation (particularly related to the automotive industry), and advanced propulsion in response to the need for more efficient, less polluting, and higher performance propulsion systems for transportation. (We actually do have national and international recognition for work in some of these areas but would like to expand that reputation.)

2.2 Research Areas for Which a National Reputation Exists

Continue to develop recognition for work in more fundamental areas such as engineering education, fracture mechanics, non-linear optics and systems. The engineering education research involves the development and use of case studies in engineering education. The fracture mechanics work is focused on development of new, high tech materials in which fracture is a major obstacle to development. For example, these materials are increasingly found in automobiles and contribute to a cheaper, safer, lighter, less polluting vehicle. The non-linear optics explores the use of this technology for development of a whole range of sensors and materials for security, biomedical, and safety applications.

2.3 Research areas to be developed

We propose to conceive, design, and test/develop MEMS/Nano devices (ie we are concerned with applications rather than fabrication). We believe that the MEMS/Nano research will naturally lead us into bioengineering. MEMS/Nano and bioengineering are areas in which the top-20 departments are already established. Many consider these areas the future of mechanical engineering. There is no way that we are going

to approach and maintain top-20 status without a significant presence in these areas. In addition, even our undergraduates need a background in the MEMS/Nano and bioengineering areas since many jobs will depend on this background (NSF estimates 20% of GNP derived from these technologies by 2020. Government agencies are putting billions of dollars into research on these technologies). In addition there already are a significant number of faculty in this and other departments to support research providing excellent synergism with ongoing efforts, infrastructure, and personnel. Again MEMS/Nanno research results have a wonderful potential to provide high visibility for our program.

3.0 Needs for Program Advancement

The department has established programmatic goals and support goals for the department (see section 1). The support goals must be met in order to achieve these programmatic goals. In this section the support needs are categorized. Each support goal detailing our needs is presented with an explanation.

3.1 Faculty Needs

Goal 1:

Add one senior faculty member with NAE membership or the ability to be inducted in NAE. This faculty position would be one of the four positions, endowed with six million dollars in the COE, and would be a world-class leader in the MEMS/Nano/bioengineering area.

Explanation of Goal 1:

Top-20 data in Appendix A demonstrates that we would be competitive with one NAE member. We are so far behind in the proposed research area that we need a significant “jump-start” to be viable in the area. We have no one in-house with the required leadership capability. A person of the stature envisioned in goal 1 could accomplish this objective-a junior level person probably could never catch up. Also we do not need a senior level person in the other areas since we already have significant capability in those areas.

Goal 2:

Add five junior level faculty members with at least three from top-10 schools. Two of these positions would be endowed with two million dollars from the COE. The research interest of these faculty members would be as follows: vehicle dynamics/control, advanced propulsion, engineering computation, design/manufacturing automation, and MEMS/Nano and/or bioengineering.

Explanation of Goal 2.

Top-20 data in Table 1.1 demonstrates that we would be competitive with 100 graduate students requiring about 25 faculty members. At present we have 18 faculty members and one vacant position. Thus, six additional faculty members are needed. As described in goal 1, one senior faculty member is justified leaving a requirement for five junior level faculty members. The COE aims at 10 junior level, 2 million dollar endowed positions. The faculty felt that the department represents at least 20% of the COE potential so that two faculty members funded from these junior level endowments is justifiable. The areas selected are those described in section 2. There will be some retirements and moves by existing faculty over the next five years which will provide an opportunity to “tune” the faculty interests to changing requirements.

3.2 Space Needs**Goal 3:**

Procure at least 30,000 square feet of additional space and consolidate existing space. Upgrade all space to state of the art.

Explanation of Goal 3:

Sizemore and Floyd completed a precinct plan in 1998 in which they estimate, based on peer review with other institutions, that mechanical engineering needs about 2500 square feet/faculty member. Using this as a basis we need space for 6 new faculty members and the one vacant position.

This gives an additional space requirement of 17,500 square feet. The last two faculty hires have been given only a minimum of space and need at least another 2,500 square feet. The transportation peak has not been provided any additional space in Mechanical Engineering. At least 5,000 square feet is needed for this purpose. The Engineering shop (supporting

all of the College) is crowded to the point that safety is a significant issue. An additional 2,500 square feet is needed for the machine and electronics shop.

Mechanical Engineering needs consolidation-for the last 50 years we have been disbursed among five or more buildings. In reaching for top-20 status the department needs a new building as planned by the University. It would be desirable for all of Mechanical Engineering to be housed in this new building and in the proposed Transportation Technology Building (this building would house transportation related labs). The proposed locations for the Transportation Technology Building and the new Mechanical Engineering building are close together which provides a convenient work environment.

We cannot attract faculty or students of the quality sought to achieve top-20 status without state-of-the-art facilities. This is true because of the perception of many outsiders of Alabama and its educational institutions. We must have an edge to overcome these perceptions.

3.3 Equipment Needs

Goal 4:

Obtain funding for special equipment needs in the amount of \$2,000,000

Explanation of Goal 4:

The ability to obtain research funding is greatly enhanced by having unique infrastructure. The Mechanical Engineering Department already has some labs that provide this advantage. We need more in order to more than double our research expenditures. Some of the funds will come from the endowed positions that we seek. Some will come from Peaks of Excellence. We will undoubtedly need additional funds. Some of the areas requiring special equipment include vehicle dynamics, mechanical and thermal aspects of electronic packaging, MEMS/Nano/bioengineering, and educational research.

3.4 Undergraduate Scholarship Needs

Goal 5:

Provide 20 scholarships valued at full tuition for entering, high-quality undergraduates.

Explanation for Goal 5:

The first goal envisions a significant upgrade in the quality of students. From recent experience in the College, it is known that these scholarships will allow us to attract students who otherwise would not come to Auburn. A review of the top-20 data shown in Table 1.1 demonstrates that top-level institutions provide this type support. We felt that Goal 9 could not be fully realized without this level of scholarship support based on these observations.

3.5 Graduate Financial Support Needs**Goal 6:**

Establish 20 graduate fellowships at a value of \$20,000 each annually.

Explanation for Goal 6:

This goal is the linch pin for the entire plan for the Auburn University Mechanical Engineering Department's effort to position for top-20 status. We can support a number of graduate students on RA's but funding fluctuates. We need to be able to advertise nationally and internationally for graduate students and be able to make strong offers to exceptional students. Without the steady support offered by fellowships, we are forced to accept students who are rejected by the top-ranked departments. The level of the proposed fellowships is commensurate with the data for top-20 departments shown in Table 1.1.

Goal 7:

Maintain 25 GTA's and 50 GRA's at a value of approximately \$1,600 per month.

Explanation for Goal 7

A quality graduate program requires that almost all students in the program be supported at a level competitive with top ranked schools. Goal 7 accomplishes this requirement. It requires approximately a million dollars in research funds to be obtained by the faculty, which is consistent with faculty goals for research funding. The GTA support is more problematic. We need approximately \$150,000 additional annually in college funds to support the goal proposed (currently we have 25 GTA's supported at half the value needed).

3.6 Technician Needs

Goal 8:

Develop staff infrastructure to support the graduate program envisioned.

Explanation for Goal 8.

Active and aggressive graduate recruitment is required to achieve goals 10 and 11. It is not efficient to use faculty exclusively for this effort. What is needed is a qualified staff person to market and recruit for the graduate program. This person would also aid in proposal development that is needed to support the level of research funding required. We do not have a staff position for this purpose. Approximately \$35,000 in continuing funds is needed to maintain this position.

There is also a need for a full time laboratory manager to maintain research labs. Faculty simply cannot serve as mechanical and electronic technicians and perform at the level envisioned. Without a full time lab manager, safety will be compromised with the dramatically increased level of research activity envisioned. We do not have a staff position for this purpose. Approximately \$35,000 in continuing funds is needed to maintain this position.

4. Programmatic Goals

The department has established programmatic goals and support goals (section 3) for the department. In this section the programmatic goals are categorized. Each programmatic goal is presented with an explanation.

4.1 Enrollment

Goal 9:

Improve the quality of the undergraduate student body and control the number of students admitted into the Mechanical Engineering program at a level between 250 and 300. The improvement in quality will result in our program being recognized in the state and nationally as significantly better than any other program in the state. Raising the GPA required to enter the program to approximately 2.5 and modifying the MECH2000 exam to make it a prerequisite to entering the Mechanical Engineering program will allow this goal to be accomplished.

Explanation for Goal 9:

Many factors influenced the decision to arrive at this goal. First, many departments in the top-20 are at this level of student population—particularly those that have faculty levels commensurate with the Auburn level. Hence, this level provides a viable platform for top-20 status. The bottom third of our current student population is poor and requires a disproportionate amount of faculty time and does not add to our reputation. Eliminating these marginal students will enhance reputation that is a key element necessary to achieve top-20 status. It is recognized that many people in the state of Alabama expect Auburn to educate these marginal students. However, the state has chosen to provide more mechanical engineering programs than needed so that these students still have an opportunity to receive an education in the state elsewhere. We desire to have the premier mechanical engineering program in the state and have the population recognize its quality. What is envisioned is that the student body in Mechanical Engineering at Auburn University will initially decrease but that gradually top students in the state will recognize that Auburn University has the premier mechanical engineering program and will come here rather than the six other programs in the state. This will ultimately result in a student body of approximately the same size as exists now but with the current bottom third of our students replaced with students having capabilities commensurate with our current top-level students.

Another important result of this improvement is the increase in the number of our graduates who are capable of doing quality graduate work. As will be noted later, the quality and number of students in our graduate program are key to positioning ourselves for top-20 status.

Goal 10:

Maintain a MS degree student enrollment at approximately 50 students with a rate of granting MS degrees between 20 and 30 per year. At the same time dramatically improve the quality of the MS student body as measured by entrance credentials and graduation rate.

Explanation for Goal 10:

Based on the top-20 departmental data shown in Appendix A, a faculty to graduate student ratio of approximately 4 to 1 appears optimum (As an example look at number 13th ranked Carnegie Mellon with 21 faculty and 75 graduate students). We believe a faculty level of 25 is a reasonable

goal so that our graduate student enrollment should be approximately 100. Looking at the top-20 data in Table 1.1, it is clear that the number of PhD students and MS students should be approximately the same. Hence, 50 MS students are selected as a goal.

Goal 11:

Maintain a PhD student enrollment at approximately 50 students with a rate of granting PhD degrees between 10 and 15 per year. Establish uniform qualifying exams and require two refereed papers before graduation. At the same time dramatically improve the quality of the PhD student body as measured by entrance credentials and graduation rate.

Explanation for Goal 11:

The goal for PhD enrollment is selected on the same basis as described for Goal 10. Reputation is built on quality and we believe the quality of our PhD's would be improved by establishing uniform qualifying exams and requiring peer-reviewed publications.

4.2 Faculty

Goal 12: *Reach and maintain a faculty level of 25 faculty with approximately equal distribution of Assistant, Associate and Full Professors.*

Explanation of Goal 12:

At present we have 18 faculty members and one vacant position. Based on top-20 data shown in Table 1.1 we feel that a faculty size of 25 is sufficient. Thus, six additional faculty members are needed (see goals 1. and 2). There will be some retirements and moves by existing faculty over the next five years which will provide an opportunity to “tune” the faculty interests to changing requirements.

4.3 Research Awards

Goal 13:

Maintain a research expenditure rate of \$250,000 per faculty member.

Explanation of Goal 13

The COE is proposing a faculty level of 210 people and research expenditures of 45 million dollars. This comes to an expenditure rate of approximately \$215,000 per faculty member. The Mechanical Engineering Department can perform at a higher level. The lower tier of the top-20 Mechanical Engineering Departments are performing at the \$250,000 per faculty member level. Hence, the Mechanical Engineering faculty selected a target goal of \$250,000 per faculty member. With a faculty number of 25 this gives an annual research expenditure of \$6,250,000, which is higher than five Mechanical Engineering Departments now residing in the top-20.

In order to achieve this level we will need to bring at least one center into the department. There are several possibilities on the horizon including automotive technologies, vehicle dynamics, and educational research. The center could easily require additional space not accounted for under Goal 3.

4.4 Scholarships

Goal 14:

Maintain a total of approximately 40 scholarships for undergraduates.

Explanation of Goal 14:

With the 20 new scholarships set as Goal 5 and the other scholarships already available (approximately 20), we would have support for over 10% of our student population. This level of scholarship support is essential to our goal of improving the quality of our incoming students.

4.5 Fellowships and other Graduate Student Support

(See goal 6)

At present we do not have any graduate fellowships. Goal 6 sets a requirement for 20 graduate fellowships. Under the explanation of goal 6 these fellowships are shown to be essential to our entire strategic plan. Twenty graduate fellowships compares reasonably with many of the top-20 schools.

(see goal 7)

We also have set a goal of maintaining 25 GTA's and 50 GRA's at approximately double the current rate.

4.6 Technicians/Administrative Support

(see goal 8)

Goal 8 sets out the requirement for one additional staff person to handle graduate recruitment, etc and one additional lab technician. At present we have 3 technicians and 4 Administrative support staff. Meeting goal 8 will bring us to a total of 4 technicians and 5 administrative support staff.

4.7 Summary

Table 4.1 summarizes the programmatic goals

Table 4.1 Summary of Programmatic Objectives

Metric	Current Status	Desired Level in 2008
Enrollment:		
undergraduate	450	300
MS	50	50
PhD	25	50
Faculty Numbers:		
Assistant Prof	2	9
Associate Prof	5	8
Professor	11	8
Research Awards per faculty member	Approx \$100,000	\$250,000
Scholarships	20	40
Graduate Support		
fellowships	0	20
GTA's	25(at \$800/mo)	25(at\$1600/mo)
GRA's	Approx 50 (at approx \$800/month)	50 (at \$1600/month)