

# DEPARTMENT OF INDUSTRIAL AND SYSTEMS ENGINEERING

## STRATEGIC DEVELOPMENT PLAN

*Website Version, Summer 2004*

### 1. Department Overview

The Department of Industrial and Systems Engineering (ISE) has been granting degrees continuously since 1932. Primary degrees have been bachelors in industrial engineering, industrial management and industrial and systems engineering. The department currently offers four degrees – BISE, MISE, MS and PhD. There are nearly 4000 living alumni of the department. These alumni are particularly diverse in their business segment and job title. Our students go into the manufacturing and service sectors as well as governmental service. The department is currently ranked 20<sup>th</sup> by the *Gourman Report* in graduate programs and 25<sup>th</sup> in undergraduate programs. Previously unranked by *U.S. News and World Report*, the graduate program was ranked 22<sup>nd</sup> nationally in 2004.

The department currently has six full professors, two associate professors, three assistant professors and one research assistant professor. The department has three full time secretarial staff positions and one academic advisor position.

#### 1.1 Enrollment, Past and Present

Table 1 indicates figures from Fall terms in OASIS for PIE and ISE enrollments. Also included are PhD graduates each year. Keeping in mind that 1999 was the final year of the quarter system, undergraduate enrollment shows a healthy upswing over the past several years.

Table 1. ISE Fall Enrollments and Projections (source: OASIS).

Enrollment (Fall term)	1996	1997	1998	1999	2000	2001	2002	2003
ISE Ugrads			84	102	74	64	60	63
PIE Ugrads			34	13	40	63	68	80
Total UG			118	115	114	127	128	143
MS's			29	32	35	47	42	38
PhD's			13	15	14	14	17	28
Total Grad			42	47	49	61	59	66
Total			160	162	163	188	187	209
PhD Graduates	1	7	3	6	2	4	3	1

On the graduate side, we are seeing a steadying of MS level enrollments and, in fact, a decline from 2001 to 2003. We attribute this to (a) a decline in the economy, which has drastically

curtailed off campus (video) MS enrollment, and (b) a concerted effort to bring in more doctoral students.

As a side note, our department is very much a mid-sized department relative to all other U.S. Industrial Engineering departments and small relative to most "Top 20" departments. Faculty sizes of other ISE departments can range from 4 to over 50. We graduated 3 PhD's in 2002 and 1 in 2003.

## 1.2 Research

Over the past several years, ISE has moved dramatically from an external funding expenditure level of about \$250K per year to just over \$1M per year (Table 2). This is due to the increase in the number of faculty members and the increased energy expended in securing external sponsorship by all faculty members.

Table 2. Annual External Research Expenditures for ISE including OSE Center and CAVE Portion (source: Ginn College of Engineering Reports).

1997	1998	1999	2000	2001	2002	2003
\$251,704	\$276,990	\$222,688	\$542,585	\$562,772	\$1,051,283	\$1,170,029

Our primary sponsors are federal – National Science Foundation (NSF) and National Institutes of Occupational Safety and Health (NIOSH). While being sizeable grants these are also prestigious. These are fully peer reviewed and highly sought after. Continued concentration on these sources will do much to elevate our national rankings. Other sponsors are corporate contracts (mainly through the CAVE Center), NASA and local government and other governmental support such as the U. S. Forest Service, federal Department of Transportation and Sandia National Laboratories.

## 1.3 Summary of Strengths, Weaknesses, Opportunities and Threats

**STRENGTHS (unordered):** long and distinguished heritage, large and high achieving alumni body, uniformly productive and harmonious faculty, solid secretarial staff, relatively healthy financial situation, good reputation among peer departments nationally, excellent success with prestigious National Science Foundation grants, federally funded center for occupational safety and ergonomics, growing student body, graduate tuition fellowships for TA's and most RA's, unusual MBA/MISE dual degree program.

**WEAKNESSES (unordered):** lack of technical staff, substandard and overly crowded facilities, outdated major equipment in manufacturing, uncertain and inadequate university budgets, erratic salary treatments, undersized faculty for research expectations, inadequate scholarships, lack of graduate fellowships.

**OPPORTUNITIES (unordered):** participation in the information technologies pinnacle, integration to the transportation pinnacle, hiring at least one new faculty member (for existing opening), pursuing additional federal funding through DOD and NASA, moving to the Transportation Technology Building, growing the graduate program – both on campus and

outreach, increasing research and education in electronics manufacturing, interaction with Hyundai and its suppliers.

THREATS (unordered): resignation and retirement of faculty, too many IE programs in the state competing for students, political attention and local research.

## **2. Research Focus Areas**

ISE is a diverse field and we are a faculty with wide interests and expertise. We also uniformly have an enthusiastic attitude towards interdisciplinary research. We have selected several areas to focus on (below, unranked), however this does not preclude involvement in other areas.

- Human performance – includes ergonomics, human factors, work measurement, human-informational interfaces and avoidance of musculoskeletal injury. Applications of interest include truck driving (including logging) and public sector productivity. (Transportation Peak)
- Safety – includes industrial hygiene, emergency preparedness, warning displays and general occupational safety.
- Electronics manufacturing – includes reliability and high volume manufacturing. (Information Technologies Peak)
- Homeland security – includes intruder detection, emergency preparedness, simulation, financial aspects, manpower allocation and staffing. (Information Technologies Peak)
- Analysis, modeling and optimization – ISE can be a resource in data analysis, modeling of stochastic and deterministic complex systems, and optimization of large systems. Applications complementary to Ginn College of Engineering research include statistical analysis and inference, scheduling and logistics, facility design and cost estimation. In particular, ISE desires integration into the Transportation Peak. We believe we offer important and useful expertise in simulation, data analysis and modeling, human factors, ergonomics and safety that would complement and strengthen existing CE, ME and AE efforts. (All Research Peaks)
- ERC – with ISE's strong national reputation and large number of NSF grants (relative to other Ginn College of Engineering departments), we believe that we can be key players in an engineering research center effort. Almost any ERC endeavor could use the research skills of the ISE faculty as lead PI's.

## **3. Needs for Program Advancement**

### 3.1 Faculty Needs

We have selected the following additional faculty positions, in order of priority:

1. Human factors with focus on transportation (junior position). Would provide the perception / cognitive expertise to complement our expertise in the ergonomics and physiology for drivers. This would fall under the Transportation Peak and would synergize with the asphalt test track. We have identified a highly qualified junior person who could possibly fill such a position should it materialize. Funding sources are Department of Transportation and Federal Motor Safety along with those with special interests such as logging.
2. Manufacturing processes (junior or senior position). This is a core IE area which is not currently covered by any full time faculty member. Retired professor, J Black, has continued to teach our undergraduate required course but a permanent solution needs to be implemented. Besides teaching, this position would perform research to complement CAVE and perhaps efforts in materials engineering in casting and laminates.
3. Operations research with emphasis on transportation (junior position). This addition will add strength to our core expertise in modeling, optimization and simulation. Application areas of expertise would be those related to transportation including routing, sizing, multi-modal facilities. This will support efforts by AE, ME and CE in the Transportation Peak as well as develop new funding sources through FAA, DOT and NSF. Premier programs in transportation such as those at Princeton University and MIT include a heavy emphasis on operations research, that is, modeling and optimization. This position can also contribute to the Information Technologies Peak, particularly the wireless programs where optimization is a key skill.
4. Materials processing (mid level position). This position is complementary to number 2 (above) but would have a greater materials focus. Primary research would lie within the vehicle electronics area and we would prefer to hire someone with automotive industry contacts and experience.
5. Process control (mid level position). This position is complementary to numbers 2 and 4 (above) but would focus on the manufacturing aspects of high volume electronics. This would support both the vehicle and wireless areas. The faculty member would have strong statistics background with a preference for experience and contacts in the electronics manufacturing industry.
6. Human factors with safety focus (junior or mid level position). This person would provide needed perception and cognitive expertise for our research focus in safety, including the emerging area of warning displays. Research sponsorship opportunities have been identified at NASA, the U.S. Forest Service and DOD.

### 3.2 Equipment Needs

For ISE, we would like to acquire:

- Truck driving simulator (\$500K). Supporting research under the Transportation Peak and synergizing with the asphalt test track. This will enable research in truck driver fatigue, road design, cab instrumentation, etc.
- Variable speed lathe (\$100K). With dynamometer and virtual quick stop. This will support education and research in manufacturing processes, a core ISE competency.

- Advanced balance master (\$75K). Enables research in worker stability, considering both physiology and cognitive aspects.

### 3.3 Undergraduate Scholarship Needs

The department currently has six departmental scholarships for undergraduates. Several of these have certain specifications (gender, place of residency). If we plan an undergraduate enrollment of 160, we feel that six is not a sufficient number of undergraduate scholarships to recruit the best engineering students.

Increases in undergraduate scholarships will concentrate on those for freshmen, which will allow us to compete for outstanding high school students with an interest in IE. We particularly need scholarships for freshmen that can be given to non-Alabama residents, in particular, Florida and Georgia residents. If a student wants to study IE in Georgia, the only real possibility is Georgia Tech. This is the top ranked program nationally but is still not a desirable choice for many students (and their parents) because of the location and the deficit college atmosphere. Therefore, Auburn is well placed to attract many of the top Georgia students; however scholarships are needed to overcome (a) the Georgia Hope Scholarships and (b) the triple out-of-state tuition. The same can be said for Florida except that Florida has many more choices of IE programs (University of Florida, Central Florida, South Florida, Florida State / A&M, Florida International and University of Miami). However, only the University of Florida is competitive in ranking to Auburn for IE.

As a secondary target, we would like multiple smaller scholarships for sophomores for retention purposes. These might take the form of book scholarships, perhaps on the order of \$500 or \$750 per year.

Summarizing scholarships, these can and will be used to attract academically accomplished students with great promise. We are competing on a regional and sometimes national basis for these students. The positive outcomes of attracting such students are increasing the number of high achieving / high potential alumni.

For ISE, by 2008, we would like to see an additional five unrestricted undergraduate scholarships that pay full tuition. We will use these to attract top high school students interested in Industrial Engineering. We would like to see 15 small sophomore level scholarships, probably in the guise of book scholarships.

### 3.4 Graduate Fellowship Needs

Summarizing fellowships, these can and will be used to attract academically accomplished students with great promise with an emphasis on U.S. students. We are competing on a regional and sometimes national basis for these students. The positive outcomes of attracting such students are increasing the number of high achieving / high potential alumni. Particularly, on the doctoral side, these students can be placed as faculty members at good institutions. For a program's prestige factor in national rankings, placing its doctoral graduates in faculty positions at esteemed U.S. institutions is critical.

By 2008, we would like to see five doctoral fellowships of the type outlined above. We will use these to recruit, on a national basis, exceptional incoming PhD students.

### 3.5 Technician Needs

Every department should have some technical staff, even if it is only part time. Installation, maintenance and upgrade of equipment are just as important, if not more so, than the initial specification and purchase of the equipment. ISE would like:

- Technical Staff Member (1/2 time) to provide support for all equipment in the department.

## **4. Programmatic Outcomes**

Table 5. Programmatic Outcomes for ISE.

<b>Metric</b>	<b>2002</b>	<b>2003</b>	<b>2008</b>
<b>A. Enrollment</b>			
BISE	128	143	160
MS	42	38	45
PhD's	17	28	35
Total Graduate	59	66	80
Total	187	209	240
<b>B. Faculty</b>			
Assistant Professors	3	3	5
Associate Professors	3	3	6
Professors	4	4	6
Total	10	10	17
<b>C. Annual Research Expenditures</b>	\$1,051,283	\$1,170,029	\$2,000,000
<b>D. Scholarships</b>	6	6	26
<b>E. Fellowships</b>	9	9	15
<b>F. Technicians</b>	0	0	0.5

### 4.1 Notes Concerning the Programmatic Outcomes in Table 5.

#### *Enrollment:*

We have set a 2008 goal of 160 undergraduates, or approximately 40 students per class. This will allow us to maintain one section per year for most ISE classes, which is what our current teaching faculty size will support.

We plan on a nearly level MS enrollment with a target of 45 for 2008. However, we have discussed the possibilities of adding two specialized MS curricula. These are a concentration in electronics manufacturing (joint with ECE and ME) and a masters of ergonomics. The latter leverages our rather unique expertise in occupational safety and ergonomics. It would be aimed at students, primarily working (outreach), who do not have engineering BS degrees. However, since we have not concluded whether either of these MS programs should be pursued, we have not included their expected enrollments in the goals above.

We are directing our efforts to further increase the number of PhD students in our program and project more than doubling the enrollment to approximately 35 by 2008. This is an ambitious goal but one that we think the department can achieve and one that would fit with our faculty size and research activity levels. In particular, our latest National Institutes of Occupational Safety and Health (NIOSH) grant for our Occupational Safety and Ergonomics (OSE) Engineering Research Center specifically addresses and funds producing PhD graduates in these areas, of which there is a severe national shortage.

*Faculty:*

These goal numbers are predicated on the normal advancement and possible retirement of the existing faculty and the incoming rank levels of the projected faculty additions.

*Research Expenditures:*

Although ambitious, we project a 2008 level of external research expenditures of \$2M, twice our current level and more than eight times the level of 1999.

*Scholarships and Fellowships:*

The new scholarships consist of five full tuition and 15 small "book" scholarships. The existing fellowships are tied to our federally funded Occupational Safety and Ergonomics (OSE) Center and are restricted to U.S. citizens or permanent residents specializing in OSE. We anticipate a growth of the OSE fellowships from nine to ten. The five new fellowships would be unrestricted in research area or national affiliation but would be restricted to PhD students.

#### 4.2 Other Goals

There are some other goals and ideas that would enhance the health of this department and its national ranking. These are discussed below.

Some of the better ranked IE programs in the country are becoming **endowed** at the departmental level. These include Penn State and Virginia Tech. Endowments are between \$5M and \$10M for departmental naming. With the abundance of extremely capable ISE alumni from our department, it seems that one could be identified to endow and name our department. While providing a stream of reliable income to supplement the University budget, this will also add prestige among our peer IE departments and thus contribute to future national rankings improvement.

While it is easy to focus on research funding because of its unequivocal measurement, scholarly visibility is also important to national rankings. This includes **journal editorships**, publications in prestigious journals, and authorship of widely used books. Our department has done very well in this area and there is no doubt that this has contributed to our current 20<sup>th</sup> national ranking in the *Gourman Report*. We house three major journals in the department (*Journal of Manufacturing Systems*, *Journal of Manufacturing Processes*, J Black, editor in chief of both, and *The Engineering Economist*, Chan Park, editor in chief). Our faculty are all, without exception, publishing annually in mainstream journals. While Chan Park has authored the most popular

string of engineering economics textbooks in the country (and probably in the world), we have other important **authorship accomplishments**. Bob Bulfin, jointly with Dan Sipper of Israel, has authored a leading production textbook. J Black has jointly authored the definitive work in manufacturing processes, now in its 9<sup>th</sup> edition, and has a new text in lean manufacturing out. To sustain and possibly improve on these accomplishments requires investment along the lines of course release time and sabbatical leaves, neither of which is supported financially by the University. To maintain major journals in the department requires staff support for coordination, mailing, tracking, etc. Both of these resource needs support high visibility scholarly work and are deserving of development.

## 5. Summary

We believe we have a crafted a plan that is challenging but achievable. The student and research dollars numbers are predicated on the current faculty size of 10 to 11. Should any of the additional faculty positions become reality, then we would project a further increase in research funding and graduate student enrollment. Likewise, should any of the major equipment pieces become reality, we would expect a related increase in research dollars and also graduate student enrollment (supported by those research dollars).

Although ISE is not a large department in the Ginn College of Engineering, with its long heritage, its disproportionate share of high achieving alumni and its solid national stature among peers, it can contribute significantly to the elevation in rankings of the College. Furthermore, the interdisciplinary orientation and breadth of expertise of the faculty engenders greater integration to College wide research efforts than has been achieved in the past. Finally, as any academic knows, the reputation of a department depends very much on the faculty members. It is a high priority to retain the current set of faculty members and to recruit new members, when the opportunity arises, who are committed to a long term association with Auburn University.