



Alumni Newsletter

Department of Industrial and Operations Engineering

Where is IOE Heading?

By Jeffrey Liker, Newsletter Editor and Associate Professor, IOE

As we approach the new millennium we decided to devote an issue of the alumni newsletter to some reflection and forward thinking on the future of IOE as a professional discipline. The new millennium will bring more challenges than changing computer systems to recognize more than two calendar digits. The world facing today's IOE graduates is dramatically different than the world I faced when I graduated as an industrial engineer in 1976. For one thing, virtually all of my fellow I.E. graduates were white



The reflecting pool, a gift of the Engineering class of 1947, adjacent to the IOE Building and Center for Ergonomics, was dedicated on October 31, 1997.

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males. The thought of a fellow industrial engineering student going to the Miss America pageant at that time was inconceivable (except perhaps in a day dream as I struggled to work on a linear programming problem). Today, our diversity in the classroom closely reflects the diversity in the U.S. When I graduated from college many of my fellow students expected to work for one large company for most of their careers. Today the half life of a job seems to be a few years and everyone wants to be an outside consultant. And the changes go on and on—the demand for a wide range of social skills in addition to technical skills, the necessity of working comfortably with computers, the need for involving people broadly in the process of change, and the rate of change itself. In this issue I asked some of my colleagues in IOE as well as some of our alumni active in the IOE alumni association to reflect on where IOE is headed. I hope you enjoy their musings.



Where are we heading? That question has been on the minds of the IOE faculty this year as we prepare for the next millennium. I am sure that many of you have probably been caught up in millennium projects as well (and some of you may even be making a business out of them!). This issue of your alumni newsletter provides some of our views.

The IOE department's look at the future has included a strategic planning process for outlining goals for the department. We have been trying to identify trends and see how we can meet the great demand increase forecast by the Bureau of Labor Statistics growth projections (in particular, for operations researchers and systems analysts). As IEs, we have recognized that meeting that surge will require some combination of resource increases and efficiency gains.

On the resource side, we have long recognized the increasing need for information systems and technology training of our students and hope to have the College of Engineering's approval of our hiring additional faculty in this area. We look for these new faculty to complement our existing strengths and to engage in research of long-term significance in the field.

With the advice and encouragement of our External Advisory Board, we are also exploring different models for the department that might include non-traditional faculty. Their work would focus on exploratory research and educational areas which might have high risk but also high reward potential. The life of these projects would be limited, but, from several of them, we hope to find one or two that produce new paradigms for IOE and then become part of the department's core.

Our other efforts toward reaching more people with existing resources have included a growing presence in video courses and continuing education. Three IOE classes are now being offered to remote sites via the College of Engineering's video network. We have also expanded our continuing education efforts, especially in ergonomics, from the traditional Engineering Summer Conferences to short courses at other locations, web-based classes, and a wider presence at the annual Management Briefing Seminars in Traverse City.

Our curriculum look at the future has consumed much of our energy over the past year. We are now committed to offering our undergraduate and beginning graduate classes on either a 2-credit, 7-week or 4-credit, full-term basis. We are re-crafting each course to fit this framework while we also try to ensure that we meet outcome objectives in the skill areas you have helped us identify.

With each of these efforts under way, the department aims to maintain and strengthen our position at the forefront of IE departments internationally. To help us shape our vision, I would like to hear your thoughts about where our field is going and how the department should respond. And, check views of our building on our web site (www.engin.umich.edu/dept/ioe/). Please visit often.

– John R. Birge, IOE Department Chair

The University of Michigan College of Engineering Alumni Society will award John E. Utley the Industrial and Operations Engineering Alumni Society Merit Award at the College's annual Alumni Society Awards Dinner which will be held on October 31, 1997.

The Alumni Society Merit Awards were established to honor alumni who personify the College's tradition of excellence and who have achieved significant accomplishments in their professional life. The Award is given to one alumnus from each of the eleven academic departments within the College. Recipients are selected by the departmental committees whose members are chosen and headed by the department chair.



John E. Utley is senior vice president of strategic marketing for Lucas Varsity. He earned his bachelor's degree in industrial engineering from the University of Michigan in 1964. He also earned an MBA from Wayne State University in 1972. Upon graduating from Michigan, Mr. Utley spent 18 years in various capacities with the Timken Company, rising to the position of assistant general manager of sales for the automotive division.

In 1982, Mr. Utley joined the Kelsey-Hayes Company as vice president, sales and marketing for the automotive group. He was appointed president of the automotive group in 1984 and was promoted to president and COO of the Kelsey-Hayes Company in 1988.

Kelsey-Hayes was subsequently acquired by Varsity Corporation, which has since merged with Lucas Industries. Mr. Utley's career continued to progress throughout this time, and he currently holds the position of senior vice president of strategic marketing for Lucas Varsity, and vice president of sales and marketing of light vehicle braking systems. He has also served as chairman of the Hayes Wheels Company, the Dayton Walther Corporation, and the Kelsey-Hayes Company.

Mr. Utley has been active in several professional organizations, including the Society of Automotive Engineers (SAE). He served as chairman of the SAE International Congress and Exposition in 1990 and as chairman of the SAE National Passenger Car Meeting in 1984. He also served as president of the Automotive Original Equipment Manufacturers Association in 1987 and is a board member of the Motor and Equipment Manufacturers Association, the Detroit Area Council of the Boy Scouts of America, and the Citizens Research Council of Michigan. He was elected to the board of directors of Walbro Corporation in 1993 and has served on the Wayne State University School of Business Administration's Board of Advisors and as a member of the University of Michigan College of Engineering's National Advisory Committee.

Mr. Utley is past recipient of the Wayne State University Corporate Leadership Award and the Wayne State University School of Business Distinguished Alumnus Award.

Operations Research

By Romesh Saigal, Professor, IOE

Operations Research is the science and art of optimally allocating scarce resources. The resulting decision problems are generic and a general methodology has developed around these problems. Such methodology has found many applications in both public and private sectors. These include decision problems in many diverse areas like manufacturing, telecommunications, transportation and service industries like banking/finance/insurance etc. OR tools are now routinely used to route calls along a telecommunications network, route city busses along a network of highways, schedule airlines and airline crew, manage and control inventory. This list is just a small subset of the many OR applications today.

Professionally, OR has matured into a well established and used discipline. As we move into the 21st century, and as our society becomes more integrated into the world as a whole, the complexity of interactions between individuals will increase beyond the comprehension of one individual or society unit. This will put greater demand on the available resources, both human and material. It is thus natural that a field that makes optimal resource allocations will find itself in great demand. The explosion of information and the emerging problems of human/machine interactions, may yet provide new application areas that we can only guess at today.

The need to solve even larger decision problems, coupled to an exponential growth in computing power has put new demands on bottleneck methodologies like combinatorial and non-linear optimization, dynamic and stochastic optimization and decision making under uncertainty. To cite an example of this, recently the Intel stock plummeted when it was noticed that the new Pentium 2 chip would require more wafer space than the earlier versions, and thus would require considerable investment in new plants and equipment. Such chips contain billions of transistors and placing them on a

wafer can lead to an allocation problem requiring a solution of a massive optimization problem, way beyond the capabilities of today's methodology. As we proceed towards the next century, such instances may become commonplace and survival may well depend on having such methodologies available. As resources become scarce, competitiveness demands their optimal allocation. Greater methodological developments in related areas will inevitably follow.

Challenges of the 21st Century: Care and Management of Human Resources

By Thomas J. Armstrong, Professor of Public Health and IOE

Nobel laureate Gary S. Becker states "human capital is the most important type of wealth in the U.S. and other modern nations." (*Business Week* April 14, 1997). Although automation has become increasingly important, humans continue to be our most valuable industrial resource. Work and self sufficiency are considered to be important human values in our society. This is reflected in federal regulations that help to insure work opportunities for persons of all genders, ages, physical abilities and races. In addition, many programs have been enacted at federal and state levels to help persons on welfare find work and achieve self sufficiency.

The importance of manual work is particularly apparent in small businesses that find it cheaper to operate machines and perform assembly operations with manual labor than with hard automation. The benefits of manual labor are passed on to large companies, which increasingly rely on small companies to perform their manufacturing. Many large companies still rely on internal work forces that perform intense manual labor. Examples of these can be found in food processing, construction, auto assembly, insurance and parcel handling industries.

Unemployment rates have reached record lows and many people routinely work overtime or at a second job. In many cases these trends have been paralleled by increasing worker injuries and disability. Injuries result in personal suffering and lost earnings for affected workers and in lost work and compensation for employers. Frustration over how to prevent and manage these injuries may adversely affect worker-employer relations. *USA Today* (September 18, 1997) cites a case in which several workers received a multi million dollar judgment against Levi Strauss as a result of how their injuries were managed. Levi Strauss, generally held in high regard as a desirable employer, is now faced with increasing conflicts among workers and between workers and managers.

Business Week (December 23, 1996) describes the new Toyota Kyushu factory in which automation was cut by 75% of that used in its most automated plants. While decreasing automation, Toyota also sought to make the work more physically and psychological compatible for its work force. In so doing they were able to increase productivity by 10 percent while cutting defects by 80 percent. In addition, fatigue and stress related injuries were reported to be substantially reduced. Similar experiences have been reported by other domestic and foreign employers. These programs draw on traditional work measurement and motion economy concepts and often utilize joint worker-management teams for implementation.

US employers who fail to take reasonable precautions to prevent work-related injuries may be threatened with legal action from the US and state Departments of Labor. Such actions have resulted in multi million dollar penalties for some employers and the development of specific control programs. Presently the US Department of Labor is studying how to best regulate these problems in the future. A major difficulty for both regulators and concerned employers is knowing how to measure health problems and how to design work equipment and procedures to prevent work-related injuries.

Industrial and operations engineers can be expected to play prominent roles in solving these problems. Specific research goals must include development of improved analysis tools for assessing injury and for characterizing work-related stresses, studies of the relationship between work and health patterns that can be used to establish work design guidelines; development of models that can be used for designing optimal work processes and equipment, development of flexible organizational models that will help companies devise implementation plans best suited for their situation and assessing worker satisfaction. Achieving these goals is essential if we are to maintain our position as a world class economic, political and social power.

financial objectives of the firm. Global risk management and the use of operations as a strategic force in managing risk will become increasingly important. IOE's research and teaching in this area will again aim to place us at the cutting edge of decision technology development.

The Future of Engineering and Technology Management

By Jeffery Liker, Associate Professor, IOE

Most engineers, whether they plan on it or not, eventually find themselves managing people. Many get an MBA as part of a plan to become a manager. Others are mainly interested in practicing their technical craft at first, and as time goes on discover they can make a greater impact by managing a group of technical professionals than by doing their own technical work. Engineering management in Universities got it's start by offering professional Masters degrees in engineering schools. The idea was not to provide enough finance, marketing, accounting, etc. to make them general managers, but enough exposure to organizational behavior and project management so they could manage technical projects or technical departments.

As technology has become part of everything we do, largely due to the computer revolution, we now define technology and innovation management much more broadly. Technology and innovation management includes the management of technical personnel, the management of research, development, and engineering projects, the management of technical organizations, the management of technical resources, and the management of technological systems. Each of these broad topics has many sub-topics and draws on a variety of academic disciplines. For example, organizational behavior is key to the management of project teams, whereas much of what we know about the management of technical resources is based in economics. Questions range from how to design organizations to achieve cross-functional integration; to how to pick R&D projects worthy of resource investment; to how to design entire systems (factories, service operations) to integrate the social and technical systems.

The move in much of U.S. manufacturing from mass production to lean production is one example. As companies attempt to drive out waste and improve the flow of product through their operations they learn that it is a systems issue and a people issue, not just a narrow technical issue. People must be organized into teams of multifunctional workers who are involved in continuous improvement. The facility must be laid out and the supply chain must be managed to facilitate lean product flow. People must perform jobs in standardized ways for planning purposes and for purposes of continuous improvement. Who else has the background to understand these diverse areas besides the industrial engineer?

In principle, the industrial engineer has the breadth needed to take on any of these issues. They have enough technical background to understand what engineering specialists are trying to do and to manage interdisciplinary teams; they have enough understanding of work flow and organizational behavior to manage social and technical system design; and they have the finance/accounting background to make sound capital and R&D investment decisions. I say in principle, because in reality many of the lucrative contracts for major consulting projects in these areas today go to MBAs who may or may not have industrial engineering backgrounds. When a company is undertaking a major reengineering of their business processes industrial engineering is often not the first group that comes to mind in leading the change. I believe this is a matter of how we market ourselves rather than the reality of industrial engineer's skills. Too many managers I talk to still think of I.E.s as the time and motion study guys.

This is not to say that industrial engineers are completely missing these trends. Many of our former students are working on fascinating projects that tax their technical and social skills in managing change. We are increasingly teaching teamwork and soft skills to round out the industrial engineering graduate. The Engineering Global Leadership (EGL) program initiated by Professor Jim Bean goes farther and requires I.O.E. students to develop international expertise, including language skills. So I.O.E. is positioned to be a leader in the new global era of rapid social and technical change. Are we up to the challenge?

Time Races On in Information Systems Development

By J. Dann Engels,
President, The Waypointe Companies
<http://www.waypointe.com>

The world seemed neatly ordered when I left Michigan's leafy campus in 1980, armed with an engineering degree and equipped with an education that would enable me (within my ordinary limits) to reason and (at least in some cases) to understand. It was, of course, a case of self-delusion, the arrogance of the supremely naive graduate.

What appeared obvious and immutable on the day I was granted my diploma now seems hopelessly outdated, even quaint. The world has changed dramatically and dynamically during the past 17 years, as the quantum shift from the Industrial Age to the Information Age has taken deep root and shaken more than a few paradigms.

I remain forever grateful for my education at Michigan, but today I see it more clearly for what it is — an exceptional foundation on which to build a career of consequence and important guidance for the initial steps along an unpredictable path of lifelong learning.

When I began my professional engineering career, I was (just as my professors and mentors at Michigan predicted) asked to think, to creatively design and implement solutions for some reasonably complex business problems. Yet, for all the advances in technology over the ensuing years (not to mention the additional generation of savvy U-M Engineering graduates in the marketplace), the complexity of business problems has increased exponentially.

Consider this example: You perhaps are familiar with the software brand names SAP, ORACLE, BAAN or Peoplesoft. They were not even glimmering notions during my student days, but today they dominate the global marketplace in large-scale computer software applications often referred to as

“Enterprise Applications”. The company I founded a decade ago is closely acquainted with the Big Three in that industry (SAP, ORACLE and BAAN), serving as a partner to each of them in the installation and implementation of their software packages.

These software systems, unimagined not long ago, were created to fill a gaping need and are now indispensable to many businesses. And the huge systems that are designed for big-business customers often require years and many millions of dollars to install. It is an enormous undertaking, requiring an extraordinary investment of human and financial resources on all sides of the transaction.

Competitive pressures and capital considerations loom large in all of this, along with other tensions and ambiguities. It is a well-accepted rule of thumb that the less a client customizes its software, the less an installation will cost and the greater the likelihood the installation will run smoothly. With most software packages, financial modules are installed first. Accounting integration is the core of these systems and is supposed to be relatively simple to implement. Unfortunately, however, this assumption is not always accurate. When expected installations fall behind schedule and exceed budget, boards often give instructions that compromise functionality.

As those pressures mount, the once creative and thoughtful engineers of these systems move toward template masters and in the process compromise the optimal solutions for the expedient. This compromise is further compounded by the need to make sure that all company software is ready for the Year 2000, the much-ballyhooed Millennium Solution.

ERP implementations, for many customers, have been particularly strategic. Companies have achieved significant returns and solved Year 2000 problems simultaneously.

It is clear that between now and the Year 2000, packaged software will dominate the industry, and boards will expend copious amounts of money

because company auditors assure them that they have no choice but to do so. At the same time, engineers and software professionals will be asked to do their best to fit the software to the business. During this process, a great deal of good work is likely to be ignored and eventually forgotten. At Waypointe IT, we are committed to the proposition that a significant strategic advantage can be gained for companies with the resources and the time to go beyond financial integration to operations integration and on into their supply chain.

In upcoming issues of this publication, we'll keep you informed on developments with SAP, ORACLE and BAAN, Peoplesoft especially in the context of its impact on engineers. We'll also describe opportunities and techniques for Michigan IE's to creatively engage in our craft and strategically support our organization. Further, we'll explore both the wonders and the challenges of enterprise applications, as well as examining both operations software and supply-chain integration.

In every case, in a fast-changing world, a Michigan IOE education is well-suited for those who want to play a prominent role in thinking through, understanding, and resolving creatively the opportunities that we face, both for today and beyond the year 2000.

Where is IOE Headed in Manufacturing?

By Mike Zonneville, MSE IOE, 1989

As an employee of a large auto manufacturer and active member of the IOE Alumni Academy since its creation I have been asked to share my thoughts on the direction of IOE. In my opinion, the future of Industrial and Operations Engineering in large scale manufacturing is wide ranging and continually evolving. Traditional Industrial Engineering functions (time study, work measurement, budgeting, capacity planning, facilities layout, etc.) still serve a

purpose in "Big 3" manufacturing. However, for some time this role has diminished in favor of other functions that capitalize on fundamental skills and capabilities of IOE graduates. Like any company, large manufacturers face constant competitive pressure for profitability. Success of the firm is measured by value returned to stakeholders as much as value delivered to customers. Industrial and Operations Engineers contribute to company profitability in several important ways, and can be summarized by process (manufacturing) engineering, production management, and specialized engineering skills.

Foremost, manufacturing companies like the Big 3 automakers look to Industrial and Operations Engineers as **process experts**. Skills developed through the degree program allow IOEs to effectively model and analyze complex manufacturing systems. Core skills (such as mfg. process technology, statistical techniques, engineering economy) provide the enabling tools to perform tasks from evaluating investment return to establishing machine capability and process control. Further, as large scale manufacturers turn to process automation and advanced computer technology to gain strategic advantage, IOE graduates are commonly involved in system analysis, development and implementation. Often it is an Industrial and Operations Engineer responsible for the redesign of processes that are efficiently automated or systematized. And in this environment, an IOE will be faced with finding an effective balance between automated and non-automated systems.

The processes that IOEs effect are not limited to production and are not local applications. Increasingly, large companies compete for profits in new markets around the world. With globalization comes new challenges such as developing creative ventures or business partnerships, solving obstacles inherent in international logistics and supply, and understanding and overcoming cultural differences. IOEs, with process and operations expertise, will be key to this growth.

Not surprisingly **production management** is an area U-M Industrial and Operations Engineering influences greatly. In a recent survey performed by the IOE Department, over 35% of IOE Alumni described themselves as in production management or executive positions. To achieve continued improvements, large companies are turning to new work organizations such as self directed work teams and natural work groups to achieve even greater levels of productivity. IOEs are being asked to develop the environment and resources that maximize the effectiveness of these work groups. Most challenging will be the task of managing the transition from entrenched practices to new methods of management and production.

Sales and market share pressures drive a ceaseless focus on quality. Achieving ISO9000 or QS9000 quality standards through the institution of quality systems used to be a prized goal. It is rapidly becoming a business assumption. Quality Engineering is a **specialized engineering** area where IOEs (with strong foundation in statistics, probability and SQC) are playing an increasingly important role. Other emerging concerns are driving the need for engineers with special talents. For example, compliance to local and national regulations (OSHA, MIOSHA, EPA) as well as inexpensively finding improved ways of doing work are creating demands for IOEs with ergonomics and computer simulation skills.

The opportunities and potential for contribution by IOEs in large scale manufacturing are extraordinarily diverse. The background that the degree provides, particularly from a program as sound as U-M's, makes the field nearly limitless.

Where are Services Headed?

By Vance L. Shutes, BSE IOE, 1981

Any discussion of where we area headed must begin with an explanation of where we have been. From the age of fifteen, my degree choice had already been made - Industrial Engineering. This was based on weekend introduction to IE with my dad. Once my entrance into U-M was assured, all efforts were focused toward getting the BSE IOE degree.

Given my earlier background in IE in a manufacturing setting, it was only natural that my first few jobs out of U-M were in the manufacturing arena, spanning from the Detroit area to the Los Angeles area. Upon my return to Ann Arbor, and my re-admittance to the MBA program at U-M, my career progressed into management.

Until one has served in a management position, it is difficult to understand the demands from within, from above, and from below. Having learned from a previous mentor that you should make decisions (in any position in the company) as though you are the owner of the business, it was only a matter of time until my style clashed with that of my direct manager. As this continued for an extended period of time, the entrepreneurial itch struck me right between the eyes.

Which leads me directly to an answer to "Where is IOE Headed?". It strikes me that the development of entrepreneurial skills is critical to any IOE student, whether undergraduate or graduate degree. The graduate can then pursue virtually any career path - straight into their own business, or into a corporation to hone their business-management skills until the itch strikes (as it did during my corporate career).

My entrepreneurial itch took me into a sales position as a Realtor (presently associated with The Michigan Group in Ann Arbor). The problem-solving skills learned as an Industrial Engineer serve me well in the Real Estate industry, as do the interpersonal skills learned through the numerous team-based problem-

solving experiences in various IOE courses.

Each of us works in Sales - if only to sell our employers the need to retain our skills on the payroll.

Reforming Engineering Education: Curriculum 2000 and IOE

By Stephen M. Pollock, Professor, IOE

As many of you know, the College of Engineering has embarked on a complete redesign of the undergraduate curriculum. Following the recommendations (contained in the report "Michigan Curriculum 2000" — available from the Associate Dean for Undergraduate Education) of a faculty-student task force, all undergraduate engineering degree programs are being re-organized to provide students with a curriculum that has:

- a) eight terms, each of which consists of four four-credit-hour courses (referred to as the "4x4x8" design).
- b) a common first year, containing a new "introduction to engineering" course, as well as mathematics computer programming, physics, chemistry (or biology), and electives;
- c) a number of identifiable "curricula threads" throughout the curriculum, including:
 - a demonstrated use of computers in each year;
 - the equivalent of three credit hours of communication skills
 - the equivalent of three credit hours of exposure to environmental aspects of engineering
 - professional ethics
 - the equivalent of four credit hours of dealing with uncertainty (e.g. probability and statistics)
- d) at least 12 hours of free electives

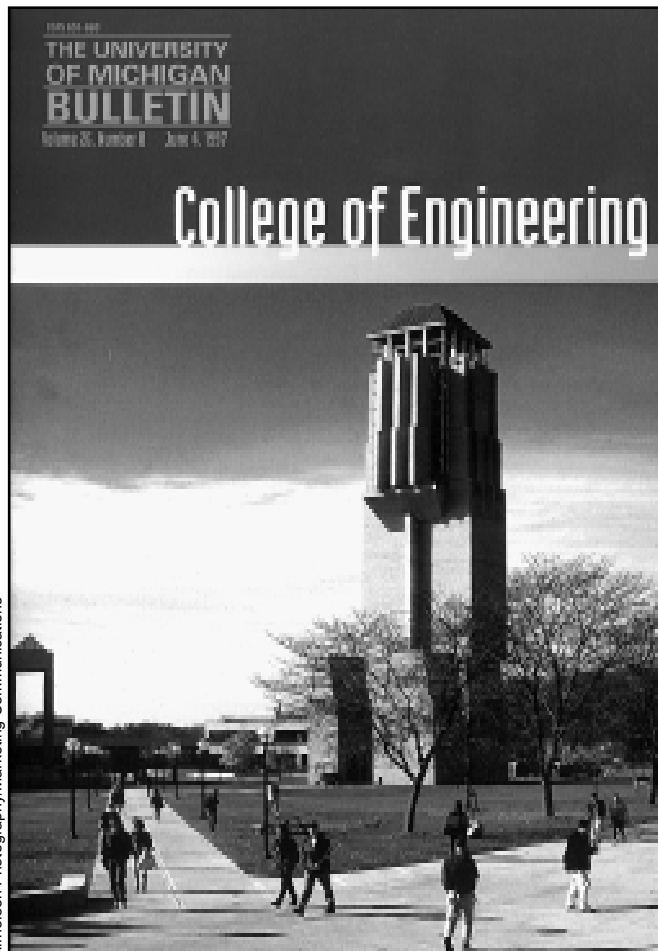
The motivations for these changes are discussed at length in "Michigan Curriculum 2000", as well as past issues of the Michigan Engineer. One expected outcome of the change is more students finishing the program within four years. The 4x4x8 design replaces the current irregular (and hard to conform to) eight terms, of four or five courses each, totaling from 15 to 17 hours. The first year curriculum will provide an early introduction to engineering concepts as well as communication, professional and ethical issues. The curricula threads and increased electives will serve to provide the broader education and opportunity for elective specialization needed by engineers in the next century.

The IOE department responded by first asking alumni, industry representatives and faculty about their perception of the necessary "skills set" our graduates should be able to demonstrate. We then challenged the faculty to re-assess, and if necessary re-design, our current course offerings courses and then produce a curriculum. One innovation was the creation of a number of 2-hour elective courses, designed to run over a half term (roughly 7 week) period. Using these, a student is enrolled in only four courses at any one time, but can be exposed to the material of two subjects instead of one. The result was an "IOE 2000" curriculum that satisfies the College's guidelines, and yet retains the flexibility and emphases that have made our IOE undergraduate program so successful and attractive in the past. It is, of course, a "living document", subject to change as our experience grows.

We will be enrolling the first cohort of students in this program as of Fall 1997, and intend to phase the program in year-by-year until it will replace the current curriculum as of Fall 2000 (an appropriate date!). The "template" that governs "IOE 2000" is essentially:

	H O U R S	TERM							
		1	2	3	4	5	6	7	8
Subjects required by all programs									
Math 115, 116, 215, 216	16	4	4	4	4				
Engin 100, Engin 101	8	4	4						
Chemistry 125/130 with lab	4	4							
Phys 140/w lab, 240 w/lab	8	4	4						
Humanities and Social Sciences	16		4		4	4	4		
<u>total common core</u>	<u>52</u>								
Related Engineering Subjects									
NON-IOE ENGIN COURSES (note A)	12				8				4
Required Program Subjects									
IOE 201/202, Industrial & Operations Mgmt.	4		4						
IOE 310, Intro to Optim Methods	4				4				
IOE 265, Engin Prob and Stat	4				4				
IOE 333, Ergonomics	3		3						
IOE 334, Ergonomics Lab	1		1						
IOE 415 (Stoch Proc.) or IOE 465 (Engin Statistics)	4				4				
IOE 373, Data Processing	4					4			
IOE Senior Design Course (IOE 424 or 481 or 499)	4							4	
<u>total required ioe subjects</u>	<u>28</u>								
Technical Electives (note B)	24				4	8	8	4	
Free Electives	12		4					4	4
<u>Total</u>	<u>128</u>	<u>16</u>	<u>16</u>	<u>16</u>	<u>16</u>	<u>16</u>	<u>16</u>	<u>16</u>	<u>16</u>

Information regarding Curriculum 2000 can be found in the new College of Engineering Bulletin. For information on undergraduate, graduate or Ph.D. programs, please call (313) 764-3297 to receive a copy.



Hirneisen Photography/Marketing Communications

note A) Select 12 hours; 4 hours from any three different groups:

- ME 211 or CEE 211 (mechanics) or ME 230 or ChE 230 (thermodynamics)
- MSE 220 or ME 281 (materials)
- EECS 210 or BioE 458 (circuits)
- AOSS 280 or CEE 380 or NERS 211 (environmental science)

note B) Select at least 16 hours from IOE; at least 4 hours must be from 3 of the following 5 groups (the remaining 8 hours may be selected from any IOE course and/or from an approved list of non-IOE courses):

- 1 — IOE 441 (production and inventory), 447 (facility planning), 449 (material handling)
- 2 — IOE 415* or 465*, 460 (decision analysis) , 466 (quality control)
- 3 — IOE 474 (simulation) , 484 (database mgt.)
- 4 — IOE 432 (instrumentation), 433 (occ. ergo), 436 (hum factors in computers), 439 (advanced safety mgt.), 463 (work measurement)
- 5 — IOE 421 (work orgs.), 438 (occ. safety mgt.), 425 (mfg. strategies), 451 (engin econ.), 452 (cap budgeting), 453 (financial engin)

*only if not elected as a "Required Program Subject"

We welcome any comments on this re-designed curriculum, and hope that if you visit you will have a chance to see it in action.

