

MEMORANDUM

TO: President Edward T. Foote II

FROM: Dr. John Knoblock ^{JK}
Chairman, Faculty Senate

DATE: April 29, 1987

SUBJECT: Faculty Senate Legislation #87010(B) - Doctor of Philosophy in Ergonomics with the joint and formal participation of the Departments of Industrial engineering, College of Engineering, the Department of Management Science, School of Business, and Department of Neurological Surgery, School of Medicine.

The Faculty Senate, at its meeting of April 20, voted to approve Faculty Senate Legislation #87010(B) - Doctor of Philosophy in Ergonomics with the joint and formal participation of the Departments of Industrial engineering, College of Engineering, the Department of Management Science, School of Business, and Department of Neurological Surgery, School of Medicine. The text of the legislation is attached.

This legislation is now forwarded to you for your action.

JK/b

Attachment

cc: Provost Luis Glaser

CAPSULE: Faculty Senate Legislation #87010(B) -
Ph.D. in Ergonomics

RESPONSE BY THE PRESIDENT:

DATE: 5/1/87

APPROVED: 

OFFICE OR INDIVIDUAL TO IMPLEMENT OR PUBLISH: _____

EFFECTIVE DATE OF LEGISLATION: _____

NOT APPROVED AND REFERRED TO: _____

REMARKS (IF NOT APPROVED):

Ph.D. Degree in Industrial Engineering (Second Reading)

A query was made about the three-year review of the Ph.D. degree in Ergonomics that was mandated when the program was approved. It was stated that the review was conducted in 1990 and the program rated positively. A copy is on file in the Senate Office. It was agreed that, in the future, copies of such reviews will be circulated to the Senate. The questions previously raised concerning the library holdings have been answered by letters from Professor Khalil and from Professor Angus Mundy expressing their views that the holdings are satisfactory as listed in the proposal. Professor Asfour explained that the computer facilities have been updated and are considered to be adequate. It was *moved* and seconded to *amend* the proposed legislation as follows: The name of the degree shall be Ph.D. in Industrial Engineering and that the present Ph.D. in Industrial Engineering (Ergonomics) shall be renamed Ph.D. in Ergonomics. The *motion to amend carried*. The *motion as amended carried*.

M.F.A. Degree in Creative Writing (Second Reading)

It was *moved* and seconded to approve the M.F.A. degree in Creative Writing contingent on the approval by the College of Arts and Sciences of the elimination of the concentration in the Master of Arts, Doctor of Arts, and the Doctor of Philosophy in Creative Writing by a normal vote of the faculty. The *motion carried* by a vote of 18 in favor, none opposed, with 1 abstention.

Ph.D. Degree in Neuroscience (Second Reading)

It was *moved* and seconded to approve, in principle, for purposes of admitting students in the fall, an interdisciplinary Ph.D. program in Neuroscience as described in the proposal. The approval of the participation of the College of Arts and Sciences is contingent on agreeing to participate in the program by normal vote of the faculty, and the preparation of a bylaw, by the Senate Council this fall, which will govern the operations of this and similar interdisciplinary programs, as described in Section 5.7 of the *Faculty Manual*. The *motion carried* by a vote of 17 in favor, 1 opposed, with 2 abstentions.

Professor Knoblock *moved* that the rules of the Faculty Senate be modified requiring unanimous consent for the consideration of any program which is incomplete, i.e., any of the items listed in the instructions from the first reading, or in the guidelines approved by the Senate previously. The *motion carried*.



M E M O R A N D U M

May 17, 1990

TO: Dr. George Alexandrakis, Chairman
Faculty Senate and Government

FROM: Dr. Pamela A. Ferguson, Associate Provost *PAF*
and Dean of the Graduate School

SUBJECT: Three-year Reports on the new Ph.D. Program in
Ergonomics and the Ph.D. Program in Sociology

After receiving the memo in April informing us of the Faculty Senate Legislation requiring a three-year review by the Graduate School of the new Ph.D. in Sociology and the new Ph.D. in Ergonomics by the Spring of 1990, we immediately informed the departments of Sociology and Industrial Engineering. They each presented a report at the May 16 meeting of the Graduate Council. Copies of the written material they provided are enclosed. In addition, Dr. Khalil, Chairman of Industrial Engineering, Dr. Asfour, Director of Graduate Studies in Industrial Engineering, and Dr. Warheit, Chairman of Sociology, provided information verbally and answered questions from the Graduate Council. The Council feels that both programs are off to a satisfactory start. A complete written report on all the graduate programs in Industrial Engineering is also on file in the Graduate School since these programs are being reviewed this fall as part of the 5-year review of all graduate programs.

As in the case of the 3-year review of the new Ph.D. in Business, the Graduate Council again suggests that it would be more useful in the future to require the initial reviews five years after the programs are instituted rather than after three years since students would be closer to graduation and the effectiveness of recruitment could be better evaluated.

If we can be of any further assistance, please call.

PAF:nb
Enclosures

cc: President Foote
Provost Glaser
Dean David Wilson
Dean Sam Lee
Dr. Warheit
Dr. Khalil

Graduate School
P.O. Box 248125
Coral Gables, Florida 33124-2220
(305) 284-4154



MEMORANDUM

TO: Dr. Pamela A. Ferguson
Dean
Graduate School

FROM: Dr. Tarek M. Khalil *mk*
Chairman
Department of Industrial Engineering

DATE: April 30, 1990

SUBJECT: PH.D. PROGRAM IN ERGONOMICS

The Ph.D. program in Ergonomics was approved in 1987. Prior to its approval, five graduate students were enrolled in the interdepartmental Ph.D. program with a dissertation topic in Ergonomics. Their progress is as follows:

<u>Name</u>	<u>Date Started</u>	<u>Graduated</u>	<u>Job Placement</u>
Elaine Marshall Asfour	1982	1987	Assistant Professor, Florida Memorial College
Ashraf Genaidy	1983	1987	Assistant Professor, Western Michigan University
Elsayed Abdel-Moty	1982	1987	Research Assistant Professor, University of Miami
Subbuswamy Muthuswamy	1984	1990	Assistant Professor, Florida Atlantic University
Sherif Waly	1987	In Progress	

Since the Ph.D. program in Ergonomics officially started in 1987, the following students have been admitted:

<u>Name</u>	<u>Date Started</u>
Waddah Fatany	1987
Sherin Kamel-Ali	1987
James Koshy	1988
Mansour Tritar	1988
Soha Sadek	1990

In addition, there are four students that are currently enrolled in the M.S. program with the ultimate objective of being permitted to continue for the Ph.D.

Funded research in the Ergonomics area has increased several folds since the start up of the Ph.D. program. Ten research assistantships have been fully funded and the following research faculty were added:

Dr. Sara Czaja, Research Associate Professor
Dr. Elsayed Abdel-Moty, Research Assistant Professor
Mr. Sherif Waly, M.S., Research Associate (to start August 1990)
Mr. Ahmed Zaki, M.S., Research Associate

Faculty publication has continued to be at a high rate in prestigious refereed journals, books and conference proceedings.

If you may need any additional information, please let me know.

Faculty Senate Action #87010
Class B Legislation

At its meeting of April 20, 1987, the Faculty Senate approved a Doctor of Philosophy (Ph.D.) degree in Ergonomics with the joint and formal participation of the Department of Industrial Engineering, College of Engineering, Department of Management Science, School of Business, and the Department of Neurological Surgery, School of Medicine, subject to the following four conditions:

1. That a supervisory committee be established composed of two members from the Department of Industrial Engineering, which shall house the program, and at least one member for each the Department of Management Science and the Department of Neurological Surgery. This committee shall be responsible for determining recruitment methods, admissions, doctoral committee composition, and all other policies related to the doctoral program in Ergonomics.

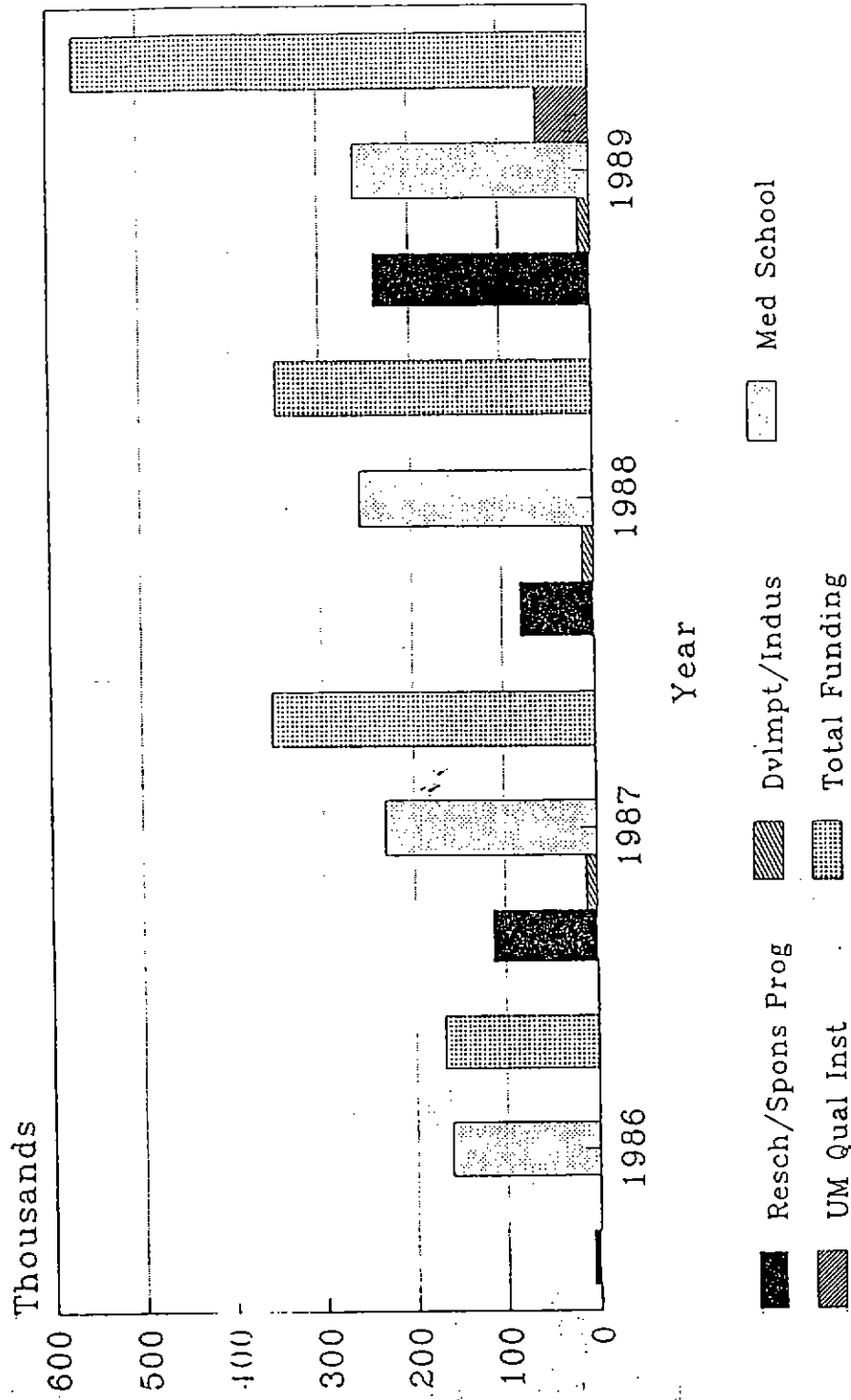
2. That admissions to the program be initially restricted to three students per year.

3. That students not be admitted to the Ph.D. program until assured of adequate resources, as specified in item (b) of the confidential report of the Senate Council dated April 17, 1987.

4. That this approval, in accord with Graduate Council and Senate policies, is provisional requiring a formal review during the third year following approval to determine if the required conditions have been met.

[This review is due by Spring, 1990. Senate action, following a recommendation from the Graduate Council, is required to remove the provisional nature of this approval. Failure to complete the review, or an unsatisfactory review, shall automatically suspend admission to the program.]

DEPARTMENT OF INDUSTRIAL ENGINEERING RESEARCH SUPPORT FUNDING



BY FISCAL YEAR

OTHER SOURCES OF RESEARCH SUPPORT

Uncredited Research Activities	Industrial Engineering Department	Fiscal Year 1990	Amount
Acc'l #	Faculty Involved	Faculty Contact	Subject of work
	Title		
661511	Research activities in the Comprehensive	Dr. Khalil	Ergonomic Evaluation and
351171	Pain and Rehabilitation Center's	Dr. Asfour	Rehabilitation in Back
388512	Ergonomics and Bioengineering Division	Dr. Abdel-Moty	Injuries and Chronic Pain
776066		Dr. Goldberg	
779318	Research Activities with Local Companies	Frank B. Hall Burger King	Safety Engineering
771865	University of Miami	Dr. Khalil	
758346	Quality Institute	Dr. Asfour	
771865		Dr. Swift	Quality Improvement
		Dr. Ip	
		Dr. Rable	
		Dr. Omachonu	
		Dr. Boubekri	
		Dr. Sumanth	
		Dr. Rhodes	
		Dr. Kanb	
		Mr. Norman	

11.6 K

\$95K

\$260 K estimate

Table II - Program Charts

Department of Industrial Engineering
April 30, 1990

I. Students

Registered Program Title: Ergonomics
Degree: Doctor of Philosophy

II. Applications - Admissions - Qualifications

Academic Year	Applications	Admissions Offered	New Enrollments
1984-1985	0	1	1*
1985-1986	1	1	1**
1986-1987	1	1	1***
1987-1988	3	3	2****
1988-1989	2	2	2*****

Total Number of Graduate Degrees Awarded

Academic Year	Degrees Awarded
1984-1985	0
1985-1986	0
1986-1987	2#
1987-1988	1
1988-1989	0

Started program in 1982 & 1983

Note: * denotes: 1 graduated (interdepartmental)
 ** denotes: 1 graduated (interdepartmental)
 *** denotes: 1 progressing on full-time basis
 **** denotes: 1 progressing on full-time basis
 1 not currently enrolled
 ***** denotes: 2 progressing on full-time basis

Table III (Continued)

III. Student Financial Awards and Support
 Department of Industrial Engineering
 April 30, 1990

Program: Ph.D. in Ergonomics

Year Specify Awards and support	1984-85		1985-86		1986-87		1987-88		1988-89	
	\$ Amount	Number Supported	\$ Amount	Number Supported	\$ Amount	Number Supported	\$ Amount	Number Supported	\$ Amount	Number Supported
PHD										
Fellow	13000.00	2	14800.00	3	7000.00	1	8000.00	1	8000.00	1
RA					2475.00	1	21600.00	3	23400.00	3
GA									5600.00	1
PT					3600.00	2	3100.00	2	1825.00	2
Tuition Waiver	356.00	1	324.00	1	3560.00	2	21330.00	3	22620.00	4

Note: Total dollar amount does not necessarily reflect full year payment per student

COLLEGE OF ENGINEERING

Summary of Sponsored Awards -- 1986-1989

Department	1986 FY	1988 FY	1989 FY	△ 1989-1986	△ 1989-1988
BME	\$ 109,670	\$ 234,900	\$ 321,546	193.3	36.9%
CEN	485,281	898,033	667,165	37.5	(25.7)
ECE	116,505	214,045	246,168	111.0	15.0
IEN	7,750	80,911	259,638	3250.0	221.0
MEN	460,524	419,248	573,222	24.0	36.7
Administration	65,000	25,000	25,000	(61.5)	0
COE	\$1,244,730	\$1,872,137	2,092,739	68.1%	11.8%



M E M O R A N D U M

April 20, 1990

TO: Dr. George Alexandrakis, Chairman
Faculty Senate

FROM: Dr. Pamela A. Ferguson, Associate Provost *PAF*
and Dean of the Graduate School

SUBJECT: Review of Doctor of Philosophy programs in Ergonomics and
in Sociology

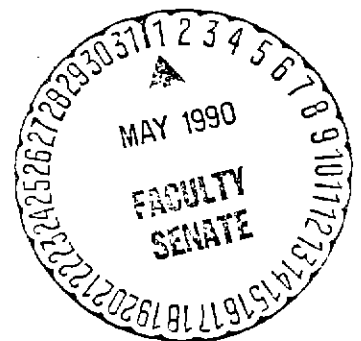
Faculty Senate legislation #85010(B) calls for a review of the Doctor of Philosophy program in Sociology and Faculty Senate legislation #87010(B) calls for a review of the Doctor of Philosophy program in Ergonomics by the end of spring 1990.

As in the case of the Ph.D. in Business, meetings with the faculty in each program indicated that complete reviews would not be particularly valuable at this time since students had not yet completed the programs. As in the case of Business, both departments are providing written interim reports to the Graduate Council. If the Graduate Council feels these are satisfactory, a complete review as part of the continuing monitoring process will occur within another three years. As you know these ongoing reviews are extensive and external reviewers are brought in. It seems appropriate to delay a large scale review until students have completed the program.

I will forward the interim reports to you when they are received.

PAF/msb

Graduate School
P.O. Box 248125
Coral Gables, Florida 33124-2220
(305) 284-4154





EXECUTIVE

COMMITTEE

May 19, 1987

MEETING DATE

BOARD OF TRUSTEES

SUBJECT:

PROPOSAL FOR A PH.D. PROGRAM
IN ERGONOMICS

PRESENTED BY:

Dr. Luis Glaser

BACKGROUND/CURRENT STATUS/MATTERS REQUIRING ACTION/
FINANCIAL IMPLICATIONS:

The Department of Industrial Engineering in joint participation with the Departments of Neurological Surgery and Management Science propose to initiate a Ph.D. Program in Ergonomics. A summary of the program is attached to this agenda.

The proposal has been reviewed by the following bodies:

4/21/86 Outside Review Committee

Dr. Don B. Chaffin
University of Michigan
Director of the Center for Ergonomics

Dr. Frank Tillman
Kansas State University
Chairman of Industrial Engineering

11/8/86 Approved by the Graduate Council

4/20/87 Approved by the Faculty Senate

5/1/87 Approved by President Foote

BOARD RESOLUTION REQUESTED:

APPROVAL of the Ph.D. Program in Ergonomics.

SUMMARY OF THE PROPOSAL FOR A
PH. D. PROGRAM IN ERGONOMICS

The doctoral program in Ergonomics is offered through the Department of Industrial Engineering with the joint participation of the Departments of Neurological Surgery, of the School of Medicine and the Department of Management Science of the School of Business Administration. Establishment of the Doctoral Program in the Department of Industrial Engineering is an integral part of the College of Engineering strategic plan for its continued development and progress. The offering of a Ph.D. Program in Ergonomics is predicated on a number of important bases. These are:

1. The national and local needs for highly qualified individual with this type of interdisciplinary training.
2. The Ergonomics area is interdisciplinary in nature. It is closely allied with the fields of anatomy, physiology, psychology, epidermiology and engineering. The University of Miami offering in these areas and in collateral fields are extremely powerful.
3. Existing faculty members in this area are internationally recognized and have strong academic credentials.
4. The Departments involved have demonstrated capability to initiate such a program.

Candidates will be required to take a minimum of 24 credits after the completion of their Masters degree. If a candidate does not have a Master degree, a minimum of 48 credits must be taken. A student have to take any additional courses as recommended by the program advisory committee.

A student must also take a qualifying examination and defend a dissertation for which he/she will register for 24 hours of dissertation research. All Ph.D. students must take a core consisting of the following courses:

IEN 612 Design of Experiment
IEN 557 Man-Machine Systems Design
IEN 558 Industrial Hygiene
IEN 657 Ergonomics and Occupational Biomechanics
IEN 659 Work Physiology
IEN 551 Accident Prevention System

M E M O R A N D U M

TO: DR. TAREK M. KHALIL
CHAIRMAN, INDUSTRIAL ENGINEERING DEPARTMENT

FROM: HUBERT L. ROSOMOFF, M.D., PROFESSOR AND CHAIRMAN *HLR*

SUBJECT: ERGONOMICS PROGRAM SUPPORT

DATE: 20 APRIL 1987

The Department of Neurological Surgery provides support to the research and application activities in Ergonomics in the amount of \$256,720.00 annually. This activity is chaired by Dr. Tarek Khalil as Director of the Ergonomics Division of our Comprehensive Pain and Rehabilitation Center. This budgeting level is sustained and has the ability to expand with increased involvement of Ph.D. graduate students and faculty from the Department of Industrial Engineering.

HLR/rc
042087
mkha2

the department had met the requirements requested by the Council. Dr. Fell, chairman of the ad hoc review committee, reviewed the recommendations of the committee. The Provost committed funding for three additional graduate assistants. Dr. Zaller withdrew his motion to defer the second reading to allow Dr. Khalil to respond to queries from the Senate. The Executive Session was adjourned.

Ph.D. in Ergonomics

Dr. Khalil joined the Senate and responded to the Committee's recommendations relating to financial support for the proposed Ph.D. in Ergonomics. He stated that the governance of the program will be done by a steering committee comprised of members from each department involved in the Ph.D. Dr. Zaller requested information on cost development and library support. It was moved by Dr. Zaller, and seconded by Dr. Heuson, to approve the program provided it meets conditions A-D in the memorandum of April 17. An amendment was moved by Dr. Yacoub, seconded by Dr. Alexandrakis, to strike condition A, and to approve the program subject to conditions B, C and D. The motion to amend the carried. The motion as amended carried.

Ph.D. in Business (Second Reading)

Dr. Knoblock presented the ad hoc review committee's recommendation stating that: 1) the program be approved in the areas of Finance, Management, and Decision Analysis; 2) the program will undergo a three-year review; 3) admission be delayed in the concentrations of Marketing and Accounting; the Dean may, with the approval of the Senate Council, fully implement the program in these areas without restriction when these areas have been appropriately staffed; 4) that Ph.D. courses be open to MBA students only under specified and limited conditions; and 5) that the School not admit students to the Ph.D. program until adequate resources are assured. Dr. Paul Sugrue responded to questions concerning personnel, admissions, space, student support and the core curriculum. It was moved by Dr. Alexandrakis, and seconded, to amend the Council's motion to include "that the School of Business and the Department of Mathematics consult on the matter of curriculum and advise the Council". The amendment carried. The motion as amended carried.

Revisions to Bylaw 9.3

The Chairman distributed the revised language for Bylaw 9.3. There were no changes proposed by the Senate.

Library Report

Dr. Edward Baker, Chairman of the Library Committee, presented the report of the Library Committee. He stated that the goal of the committee over the past three years has been to make recommendations that would allow the Library to be maintained at a fiftieth rank among the Association Research Libraries. He noted three areas of concentration: 1) the quality of the collection; 2) the physical space and resources; and 3) the professional staff. Dr. Baker stated that two trends are



Department of Management Science
and
Computer Information Systems
P.O. Box 248237
Coral Gables, Florida 33124
(305) 284-6595

April 17, 1987

TO: Dr. John Knoblock
Chairman, Faculty Senate and Government

FROM: Dr. Joel Stutz *js*
Chairman, Dept. of Management Science &
Computer Information Systems
School of Business

SUBJECT: Ph.D. in Ergonomics

This memorandum is being sent to clarify the circumstances and intent of the attached memo expressing our Department's support for the Ph.D. program in Ergonomics, housed in the Department of Industrial Engineering.

The original memorandum, dated April 3, 1987, was circulated to the faculty in our department with a request that they indicate (vote) whether or not they are in favor of supporting the Ergonomics Ph.D. as indicated in the memo. There are fifteen faculty in our department; two of them are on sabbatical leave. The response to my request was nine votes in favor and zero negative votes.

I therefore feel our department has given its vote of support and approval to the program and to participation by interested faculty within our department.

cc: Dr. Tarek M. Khalil
Chairman, Industrial Engineering Department

JS/cmm

Enclosure

CONFIDENTIAL

M E M O R A N D U M

April 17, 1987

TO: Dr. John Knoblock
Chairman
Faculty Senate and Government

FROM: Senate Council Ad Hoc Committee for Review
of Subject Program
Committee
Chairman: Dr. Jack Fell
Rosensteil School of Marine and
Atmospheric Science

Members: Dr. Linda L. Neider
School of Business Administration
Dr. Thomas J. Sick
School of Medicine

SUBJECT: Department of Industrial Engineering Proposal
for Ph.D. Program in Ergonomics

After thoroughly reviewing the (revised) Department of Industrial Engineering proposal for a Ph.D. in Ergonomics, our committee (unanimously) still had the following reservations:

- (1) According to the outside reviewers of the Ergonomics Ph.D. proposal (Drs. Chaffin and Tillman), a Ph.D. program should provide "a graduate faculty experienced in performing contemporary research in industrial engineering* and who routinely publish in scholarly refereed journals in the field." There are only two senior faculty members (Drs. Asfour and Khalil for the Ergonomics field**) in the department who fulfill this requirement. This is below the minimum standards used by

.../2

* Ergonomics

**For a more detailed faculty and resource analysis, refer to our February 5, 1987 report to the Faculty Senate Council.

- (1) (continued)
the Senate in recommending other doctoral programs.
- (2) No documentation has been provided to our committee indicating a formal financial commitment (from the School or University level) to fund doctoral students. Furthermore, the department does not presently have the external funding necessary to support such a program.

Before admitting students to a doctoral program in Ergonomics, we recommend that the following conditions be met:

- (a) One senior-level researcher in Ergonomics, with a demonstrated publication record, should be hired.
- (b) A formal letter of commitment for additional graduate assistant funding should be obtained (from the School's Dean and/or the Provost).
- (c) A program oversight committee should be formed, composed of Drs. Asfour, Khalil, and two senior faculty researchers in Ergonomics from outside the Department of Industrial Engineering. This committee should be responsible for determining recruitment methods, admissions, doctoral committee composition, and all other policies related to the doctoral program in Ergonomics.
- (d) If conditions (a) through (c) are met, we recommend admitting a maximum of three doctoral students per year to the program until the formal three-year program review process is undertaken by the Graduate School.

JF/LLN/TJS:ss



April 15, 1987

To: Dr. Luis Glaser
Executive Vice President and Provost

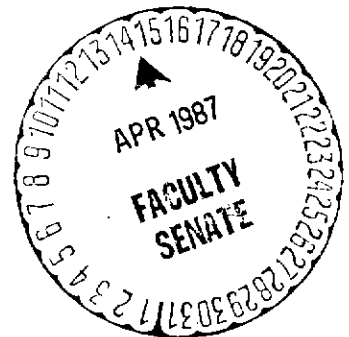
From: Norman G. Einspruch
Dean, College of Engineering

Subject: Ph. D. in Ergonomics

This is to clarify our understanding that the Ph. D. program in Ergonomics will be guided by a steering committee and housed in the Department of Industrial Engineering.

The steering committee will be chaired by the Chairman of the Department of Industrial Engineering and will have representatives from the Departments of Neurological Surgery and/or Management Science appointed upon consultation with the respective Deans.

NGE/dd
cc:Dr. John Knoblock



College of Engineering
P.O. Box 248294
Coral Gables, Florida 33124
(305) 284-2404

MEMORANDUM

TO: Luis Glaser, Provost

FROM: John Knoblock, Chairman
Faculty Senate

DATE: April 14, 1987

SUBJECT: PhD in Ergonomics

We need to know the commitment of following individuals to the proposed PhD in Ergonomics. They should specify the amount of time they expect to devote to course offerings and dissertation supervision in the program and the amount of monetary resources for graduate stipends and tuition waivers available to the program for the next three years.

T.M. Khalil (IEN)
S.S. Asfour (IEN)
M. Goldberg (Neurological Surgery)
E. Wiener (MAS)
C. Kurucz (MAS)

These five people are the heart of a viable program. It is important that the Departments understand that "formal participation" is a commitment of faculty and financial resources to the program.

Ph.D. in Ergonomics (First Reading)

Dr. Alexandrakis introduced the Council's motion recommending approval of the Ph.D. in Ergonomics in the Department of Industrial Engineering. Dr. Tarek Khalil, Chairman, responded to questions regarding funding of the program, the number of Ph.D. programs existing in Ergonomics, and the formal participation of departments in the Schools of Business and Medicine. He was asked to provide an updated financial statement, and to secure a formal vote of the faculty in the School of Business. It was requested that a more definitive description of the program be provided, including the faculty who are charged with the supervision of the program.

Ph.D. in Business (First Reading)

Dr. Alexandrakis presented the Council's motion recommending approval of the Ph.D. in Business and summarized the sub-committee's report. Dean Borsting commented on the importance of the proposed program to the School, and the sub-committee's reservation about inadequate library support for the new program. It was moved by Dr. Zaller, seconded by Dr. Yacoub, to strike "Council" in C2 so that the approval of the Senate is required to lift the restriction on admission to the areas of marketing and accounting. The amendment failed by a vote of 4 in favor, and 10 opposed.

Name Change for the Department of Religion

Dr. Knoblock presented the Council's recommendation for approval of the name change of the Department of Religion to the Department of Religious Studies. The motion carried.

Program in Physical Therapy

The Chairman requested the Senate to grant an additional year of temporary approval for the program in physical therapy since it has never been approved. The motion carried.

Establishment of Awards

The Chairman suggested the establishment of two awards: 1) outstanding contribution to knowledge, and 2) outstanding service to the University. These would be established on the occasion of the twenty-fifth anniversary of the Charter, announced at the May 4 meeting, and presented in the Fall. The motion carried.



Department of Management Science
and
Computer Information Systems
PO. Box 248237
Coral Gables, Florida 33124
(305) 284-6595

April 3, 1987

TO: Dr. Tarek M. Khalil
Chairman, Industrial Engineering Department

FROM: Dr. Joel Stutz *JS*
Chairman, Department of Management Science

SUBJECT: Ph.D. Program in Ergonomics

The Department of Management Science enthusiastically supports the Ph.D. degree program in Ergonomics housed in the Department of Industrial Engineering. This is to express our intent to formally participate in this program. Our faculty intend to become active participants in it through joint research projects and supervision of doctoral students. Example of interested faculty members in our department are:

<u>Name</u>	<u>Areas of Interest</u>
1. Dr. Earl Wiener	Human Factors
2. Dr. Joseph Moder	Design of Experiments
3. Dr. Charles Kurucz	Statistics & Design of Experiments, Accident Prevention Systems
4. Dr. Malcolm Golden	Database Analysis of Vehicular Accidents; Decision Theory Approaches to Transportation Models.

cc: Dr. Jack R. Borsting
Dean, School of Business Administration

JS/ss

M E M O R A N D U M

TO: DR. TAREK M. KHALIL
CHAIRMAN, INDUSTRIAL ENGINEERING DEPARTMENT

FROM: HUBERT L. ROSOMOFF, M.D., PROFESSOR AND CHAIRMAN

SUBJECT: INDUSTRIAL ENGINEERING PhD PROGRAM IN ERGONOMICS

DATE: 31 MARCH 1987

The Department of Neurological Surgery enthusiastically supports the PhD degree program in Ergonomics housed in the Department of Industrial Engineering. We have, in fact, been an active participant with Industrial Engineering at our Comprehensive Pain and Rehabilitation Center for the past four years for which our facilities have already been a base of operation for the students in your Department. It is a natural extension of the academic pursuit to now wish to offer the PhD degree. The Department of Neurological Surgery would not only like to see Industrial Engineering move forward in their research effort, but it is to our mutual advantage to share the joint investigative projects and participate in the supervision of doctoral students through whose efforts we will prosper together.

The Department of Neurological Surgery has faculty in specific areas of interest to Industrial Engineering with whom already we have been doing research which have resulted in publications and significant contributions to Neurosurgical and Ergonomic literature which have now gained national, and international, recognition. The PhD program would serve further to enhance this effort and acknowledgement by our colleagues. I do hope we can carry forward your doctoral program.

Examples of the Neurosurgical Faculty and their areas of interest conjoint to Ergonomics follows:

<u>Name</u>	<u>Areas of Interest</u>
1. Dr. Hubert L. Rosomoff	Low Back Pain Rehabilitation
2. Dr. David Fishbain	Pain Measurement and Behavioral Problems in Rehabilitation
3. Dr. Myron Goldberg	Ergonomics, Biofeedback, Psychological Stresses

HLR/rc
040187/mkha

cc.: Dean Bernard Fogel
Provost Luis Glaser

SENATE COUNCIL MEETING

MARCH 6, 1987

PRESENT: George Alexandrakis, William Awad, Jack Fell, Tony Harvell, John Knoblock, Chairman, Michael Salwen for Josephine Johnson, Chester Schriesheim for Linda Neider, Donald Randolph, Daryl Ries, Alan Swan, and Kamal Yacoub.

GUESTS: Jack Borsting, Norman Einspruch, Tarek Khalil, Sidney Besvinick

Call to Order and Approval of Minutes

The meeting was called to order at 2:00 P.M. by Dr. Knoblock. The minutes of the January 26 meeting were approved as submitted. Excused absences were approved for Drs. DeCarbo, Forman, Honikman, Johnson, and Neider.

Retreat

It was moved by Dr. Swan, and seconded, to set March 28 as the Senate's annual retreat to be held at RSMAS. It was agreed to meet beginning at 9:00 A.M. and continuing through lunch.

Proposed Name Change for the Department of Religion

It was moved by Dr. Yacoub, and seconded, to approve the proposed name change from the Department of Religion to the Department of Religious Studies. The motion was adopted unanimously.

Proposal for a Ph.D. in Industrial Engineering

Dr. Tarek Khalil presented the revised proposal for a Ph.D. in Industrial Engineering. He pointed out the major revisions which respond to the questions previously raised by the Council. Discussion followed regarding research funding available, teaching loads of faculty, and the GRE scores and qualifications of students. The Senate moved into Executive Session to discuss the proposal. Following the Executive Session, it was moved, and seconded, to agenda the item for the April Senate meeting, and to recommend approval of the Ph.D. in Ergonomics, to be housed in the Department of Industrial Engineering.

Proposal for a Ph.D. in Industrial Engineering - (cont.)

The program would be directed by Dr. Khalil and would involve the participation of one other department from either the School of Medicine or the School of Business, the procedures to be arranged with the Provost prior to the Senate meeting. The motion was adopted unanimously.

Proposal for a Ph.D. in the School of Business

Dean Jack Borsting presented a summary of the proposal for a Ph.D. in Business Administration with a major in one of five areas. He stated that the departments of Management Science and Computer Information Systems, Finance, Management, Accounting, and Marketing would participate in the program. Discussion followed relating to the qualifying examinations for students, whether students can be re-examined in cases of failure, and the course loads and teaching loads of graduate students. The Chairman will appoint a committee to examine the proposal in detail and submit a report to the Council.

Discussion of Bylaw on Faculty Status, Appointments, Promotion, and Tenure

Dr. Besvinick explained the Graduate Council's proposed modifications to the Charter and Bylaw changes being prepared by the Senate. In addition, a new Charter section 4.3 and a new Bylaw concerning the Graduate Council membership were proposed. He stated that the Council felt it was important to establish criteria for people to chair thesis and dissertation committees. Discussion followed. This item will be forwarded to the Senate as an information item pending graduate faculty action.

Dr. Knoblock reviewed the proposed Charter changes. Dr. Swan requested that the Law School be allowed to use "Clinical" in its titles. Discussion followed. The Council agreed to add "in the Schools of Medicine and Nursing" following "Clinical" in the second line of the Associated Faculty paragraph. This item will be forwarded to the Senate along with an amendment to the Educator Faculty section.



MEMORANDUM

March 5, 1987

TO: Faculty Senate

FROM: Associate Provost for Research and
Dean of Graduate Studies (Interim)

SUBJECT: Ph.D. Proposals for Industrial Engineering
and Business Administration

I am enclosing the above referred Ph.D. Proposals which were presented to the Graduate Council yesterday.


The proposed revised Ph.D. Program for Industrial Engineering has been approved by the Council with no changes.

The proposed Ph.D. Program for Business Administration was presented by Dr. Carroll Truss, for the Subcommittee of Programs and Degrees, and Dr. Paul Sugrue, representing the School of Business Administration.

The Ph.D. Program for Business Administration was approved by the Graduate Council with the following comments:

1. The School should prepare a carefully-designed strategy for marketing the program and recruiting students at selected universities. Necessary funds to implement this strategy should be identified.

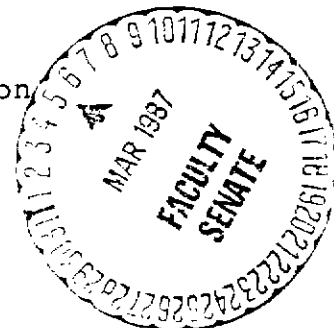
2. Scores of 600 on both the GMAT and the TOEFL test may be too rigorous and could limit admissions significantly.


Sidney L. Besvinick

SLB:nb

Attachments: IEN Ph.D. revised proposal
Ph.D. proposal in Business Administration


Graduate School
PO. Box 248125
Coral Gables, Florida 33124
(305) 284-4154





March 5, 1987

To: Dr. John Knoblock
Chairman Faculty Senate

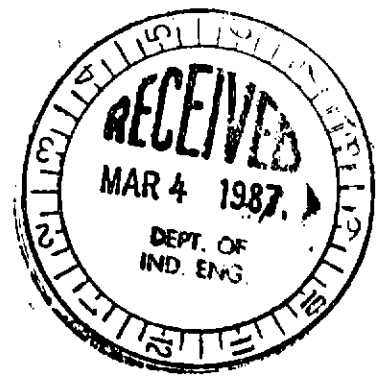
From: Tarek M. Khalil 
Chairman Industrial Eng. Dept.

Subject: Ph. D. Program in Industrial Engineering

I am enclosing herewith a letter from Dr. Charles N. Kurucz indicating his participation and support of the Ph. D. program in Ergonomics in the Industrial Engineering Department. Please add this letter to the material that was sent to your office last week.

TMK/dd
cc:Provost Luis Glaser
Dean Norman G. Einspruch

Dept. of Industrial Engineering
College of Engineering
P.O. Box 248294
Coral Gables, Florida 33124
(305) 284-2344



Department of Management Science
and
Computer Information Systems
P.O. Box 248237
Coral Gables, Florida 33124
(305) 284-6595

March 2, 1987

Dr. Tarek Khalil, Chairman
Department of Industrial Engineering
University of Miami
Coral Gables, FL 33124

RE: Industrial Engineering Ph.D. Program

Dear Dr. Khalil:

I am writing to confirm my previous expression of support for the new Ph.D. program in Industrial Engineering.

As you know I have taught required graduate courses in the areas of probability and statistical design of experiments for Industrial Engineering graduate students. I anticipate continuing this teaching activity in the future. Further, I am interested in advising and working with students as they perform their dissertation research and plan to be available to a selected number of students.

Please accept my continued support. If you need any additional information please contact me at your earliest convenience.

Sincerely yours,

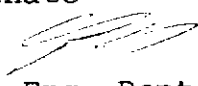
Charles N. Kurucz
Charles N. Kurucz, Ph.D.
Associate Professor

CNK/sls



March 2, 1987

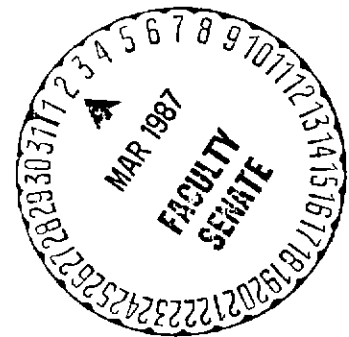
To: Dr. John Knoblock
Chairman Faculty Senate

From: Tarek M. Khalil 
Chairman Industrial Eng. Dept.

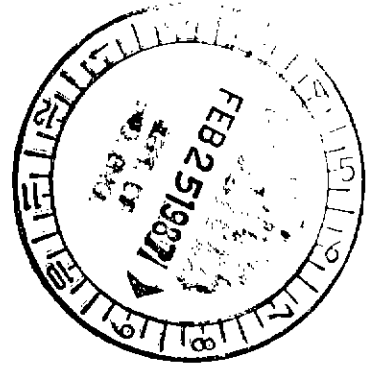
Subject: Ph. D. Program in Industrial Engineering

I am enclosing herewith letters from Dr. Earl Wiener and Dr. Myron Goldberg indicating their participation and support of the Ph. D. program in Ergonomics in the Industrial Engineering Department. Please add these letters to the material that was sent to your office last week.

TMK/dd
cc: Provost Luis Glaser
Dean Norman G. Einspruch



Dept. of Industrial Engineering
College of Engineering
P.O. Box 248294
Coral Gables, Florida 33124
(305) 284-2344



Department of Management Science
and
Computer Information Systems
P.O. Box 248237
Coral Gables, Florida 33124
(305) 284-6595

25 February 1987

Dr. Tarek M. Khalil, Chairman
Dept. of Industrial Engineering
University of Miami
Coral Gables, FL 33124

Dear Tarek:

It is with pleasure that I respond to your invitation to participate in the doctoral program in Human Factors Engineering/Ergonomics to be offered by your department.

I believe that I possibly contribute in the following ways:

1. Serve on student doctoral committees, and possibly chair a committee should the need arise.
2. Teach a course jointly between IEN and Management Science in some advanced area in Human Factors.
3. Support a graduate student on my research grant when funds are available, and a student is in a position to contribute to my research.

As you may know, my own department may go through a complex reorganization soon, so my availability will depend on the outcome, and of course the support of my new chairman. My present chairman encourages cooperation with other departments, and we especially value our continuing relationship with IEN. I appreciate the fact that you have continued my joint appointment with IEN, and look forward to playing a part in your Ph.D. program.

Sincerely yours,

A handwritten signature in dark ink, appearing to read "Earl L. Wiener".

Earl L. Wiener,
Professor

University of Miami

COMPREHENSIVE PAIN AND REHABILITATION CENTER

at

South Shore Hospital and Medical Center

Hubert L. Rosomoff, M.D., D. Med. Sc.
Medical Director

Reneé Steele Rosomoff, M.B.A., R.N.
Programs Director

February 17, 1987

Tarek Khalil, Ph.D.
Department of Industrial Engineering
University of Miami

Dr. Khalil,

Thank you for considering me for graduate faculty status in your department. Over the past few years I have sat on several masters and dissertation committees and found this experience to be highly rewarding. I believe my background in psychology, statistics, and research design has enabled me to make useful contributions in these committees, in terms of furthering the educational and professional development of the students.

I have a great deal of interest and desire to continue working with graduate students in this same capacity. I would also like to increase my involvement with graduate students by directly supervising their research. I would welcome such an opportunity in your department.

Sincerely,

Myron Goldberg Ph.D.

Myron Goldberg, Ph.D.
Research Assistant Professor



M E M O R A N D U M

TO: Dr. John H. Knoblock
Chairman, Faculty Senate

FROM: Dr. Tarek M. Khalil *(for) Norman*
Professor and Chairman
Industrial Engineering Department

DATE: February 25, 1987

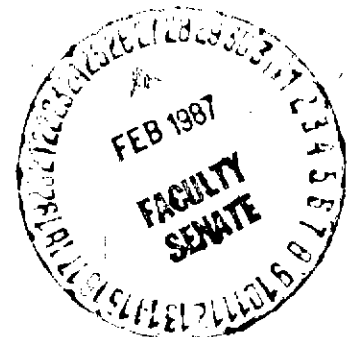
SUBJECT: REVISED PH.D. PROPOSAL

Please find attached our revised Ph.D. Proposal, which concentrates on the Ergonomics field, for consideration by the Faculty Senate. Details pertaining to the faculty and research activities in this area are covered in this document.

Should there be any further clarifications needed, please do not hesitate to contact me at 284-2344.

TMK:DJS:dsp

cc: Provost Luis Glaser
Dean Norman G. Einspruch



Dept. of Industrial Engineering
College of Engineering
P.O. Box 248294
Coral Gables, Florida 33124
(305) 284-2344



February 6, 1987

To: Dr. John Knoblock
Chairman, Faculty Senate

Via: Dean Norman G. Einspruch
College of Engineering

From: Dr. Tarek M. Khalil
Chairman, IE Department

A handwritten signature in black ink, appearing to be "Tarek M. Khalil", written over the "From:" line of the letterhead.

The Department of Industrial Engineering submitted a proposal to offer the Ph. D. program in two areas of concentration in order to be able to focus its resources and achieve excellence in graduate education and research. The two areas are 1) Ergonomics and 2) Production Systems Engineering. These two areas of research intellectually reinforce each other.

The Ph. D. proposal was reviewed by outside consultants who were selected from the leaders in the field of Industrial Engineering. The reviewers' report indicated that "The IE faculty have wisely decided to propose their Ph. D. program based on two distinct research areas within the very broad industrial engineering field."

The summary of the findings of the consultants is as follows:

1) "The Ergonomic research program applied to rehabilitation and occupational health planning in industry is well developed and could support a few Ph. D. students with only small incremental costs." (The department has supplied evidence to the Faculty Senate Council that more than twelve graduate students are currently supported by external funds in this program. This level of support has been sustained for more than five years.)

2) For the Production Systems Engineering concentration the reviewers recommended the addition of a Senior faculty member and the alleviation of heavy teaching loads (standard load at the time of the report was 3 courses per semester). They indicated that an addition of \$100,000/yr is needed to add this concentration.

Dept. of Industrial Engineering
College of Engineering
P.O. Box 248294
Coral Gables, Florida 33124
(305) 284-2344

The reviewer's conclusion was "the Department has identified two areas that they can excel in, Ergonomics and Production Systems Engineering. We believe that with this focus, the available resources and above mentioned concerns and support requirement, that a viable Ph. D. program in Industrial Engineering can be established at the University of Miami."

The Physical Sciences subcommittee of the Graduate Council after exhaustive review of the departmental resources agreed with the reviewers' statement and recommended inauguration of the program subject to three stipulations (memorandum dated July 24, 1986):

1. Addition of a professor or senior associate professor in the Production Systems Engineering area.
2. Authorization of additional graduate teaching assistants to reduce load on faculty teaching.
3. Limitation of post-master Ph. D. students to five per year for the first two years.

The Graduate Council approved the offering of the Ph. D. program subject to the implementation of the stipulations recommended by the subcommittee over the next few years (memorandum dated October 13, 1986 to Faculty Senate).

The Faculty Senate Council requested that the department submit information about funding available to support graduate students in the Ergonomics program. This information was provided in detail (memo from Dr. Khalil to Dr. Knoblock dated January 21, 1987) showing that the current level of funding is capable of supporting more than twelve students in this concentration.

In addition since the time of submission of the outside reviewers' report, the department through its outside resources was able to hire an experienced faculty member on a visiting status. The use of experienced adjunct faculty was expanded; this helped alleviate faculty load effectively reducing teaching loads to two courses and allowing the faculty more time to concentrate on research and publication.

The addition of two more TA positions can be accommodated under the budget of the highly successful MSIE/MBA weekend program.

Based on the progress that has been made since the visit of the Consultants, the faculty of the Industrial Engineering Department urges the adoption of the following:

Approve the Ph. D. program in Industrial Engineering with permission to accept three new students per year for the first three years in the ergonomics concentration.. Hold admission into the

Production Systems Engineering concentration until the following stipulations have been met.

1. Add an established faculty member into the Production (Manufacturing) System area.
2. Show evidence of increased level of funding in this area to support two additional graduate students per year (The budget allocation for our weekend executive MSIE/MBA can support two TA's to satisfy requirements in this regard.)

TMK/dd

CONFIDENTIAL

SENATE SUBCOMMITTEE REPORT

February 5, 1987

TO: Dr. John Knoblock
Chairman
Faculty Senate and Government

FROM: Faculty Senate Subcommittee for Review
of Subject Program
Dr. Jack Fell, Rosensteil School of Marine and
Atmospheric Science
Dr. Linda L. Neider, School of Business Administration
Dr. Thomas J. Sick, School of Medicine

SUBJECT: Department of Industrial Engineering Proposal for a
Ph.D. Program in Human Factors

After thoroughly reviewing the Department of Industrial Engineering proposal for a doctorate program in Human Factors, this subcommittee agreed that there were two major problem areas which need to be addressed -- departmental faculty, and research support for such a program. Our specific concerns are expressed below for each area.

Existing Faculty

In our estimation, one of the major weaknesses with the Ph.D. proposal from the Department of Industrial Engineering (specialization in Human Factors) is the lack of a viable graduate faculty. Based on an assiduous analysis of departmental curriculum vitae, we noted the following:

- o At the senior level, there is essentially one Associate Professor, Dr. Asfour, and one (full) Professor, Dr. Khalil, that could assist in the development of doctoral candidates in the Human Factors/Ergonomics area. Dr. Khalil, however, is Chairman of the department and, thus, will be of rather limited value to doctoral students in terms of theses supervision, conduct of doctoral seminars, etc.

The other two senior faculty members in this department (Dr. Pfaffenberger and Dr. Sumanth) are not trained, nor do they publish research, in Human Factors/Ergonomics.

- o There are presently three (Dr. Adaniya, Dr. Kang, and Dr. Rabie) terminally qualified junior faculty members in the department (a fourth Assistant Professor, Mr. Omachonu -- who was a former UM masters student in Industrial Engineering -- is ABD). The contribution of all three Assistant Professors to a doctoral program is questionable, at best. Dr. Adaniya, whose area is only tangentially related to Human Factors, completed his dissertation three years ago and does not have any publications. Dr. Rabie finished his doctorate four years ago and has only one refereed article. Dr. Kang, who has been out of graduate school for two years, does have a reasonable publication record. Unfortunately, his area of research is computer simulations, not Human Factors.
- o There are a number of individuals who are listed as "Industrial Engineering Faculty" who will -- clearly -- not be able to make a contribution to the department's doctoral program. Dr. Bayrakter is a Visiting Assistant Professor; further, his research is not in the Human Factors/Ergonomics area. Dr. Kurucz and Dr. Wiener are both tenured faculty members in the School of Business Administration. Although they have courtesy (secondary) appointments in the Department of Industrial Engineering, their teaching/research is done in the School of Business Administration. (In addition, the School of Business Administration is having their own doctoral proposal reviewed, which may further limit their involvement in committee work from other schools.) Dr. Goldberg is a Research Assistant Professor in the Department of Neurological Surgery, (UM) School of Medicine. He has secondary, or courtesy, appointments with the Department of Psychology, the Department of Orthopedics and Rehabilitation, as well as with Industrial Engineering. Thus, his contribution to the proposed doctoral program would be extremely minimal (at best). Finally, Dr. Rhodes

is a Community Adjunct Professor, who was formerly employed at General Electric Company, and is not involved in research activities.

- o There are only three faculty members from the Department of Industrial Engineering who are on the Graduate Faculty (Dr. Asfour, Dr. Khalil, and Dr. Sumanth). Dr. Sumanth does not teach or publish in the area of Human Factors/Ergonomics. Dr. Khalil, as noted previously, is Chairman of the department and, thus, time-constrained in terms of his ability to work closely with doctoral students.

Based on our review of the department's faculty, we can not recommend that doctoral students be admitted to such a program. According to the outside reviewers of the proposal (Drs. Chaffin and Tillman), a Ph.D. program should provide "a graduate faculty experienced in performing contemporary research in industrial engineering and who routinely publish in scholarly refereed journals in the field." Such a faculty (specialized in Human Factors/Ergonomics) does not currently exist in the Department of Industrial Engineering.

Research Support

During fiscal year 1986-87, the Department of Industrial Engineering obtained several small grants from corporations with a reported total of \$35,800. In mid-January, Dr. Knoblock informed this committee that the (UM) Grants Office reported that the Department of Industrial Engineering did not have any active grants or contracts. Therefore, it must be assumed that the listed income consists of donations to the Development Office. Some of this funding, from American Can, Burger King, and Frank B. Hall, appears to be for student support. Such support cannot be discounted, as it is important in developing and sustaining the Master's Degree Program. Also listed is a \$100,000 NASA grant to Dr. Wiener of the School of Business Administration. We believe that it is inappropriate to list funding to departments or schools other than the academic unit in question. Such double listing can be misleading.

On a historical basis (January 1986 to January 1987), other than the funding listed above, the department obtained \$65,000 in equipment, and Dr. Sumanth obtained pass-through funds from the Phosphate Research Institute.

Based on the documents provided to us, the main source of funding in the department appears to be the operating funds for the Comprehensive Pain and Rehabilitation Center (CPRC) -- \$162,000. These are pass-through funds from the School of Medicine. The department's affiliation with the CPRC is clearly the major (only) foundation on which a viable Ph.D. program may be established. Drs. Khalil and Asfour are actively involved in research projects involving the CPRC, and the CPRC appears to support a number of masters students in Industrial Engineering. Dr. Rosomoff, Chairman of the Department of Neurological Surgery, and Director of the CPRC, indicates that more than \$500,000 already has been invested in support of Industrial Engineering. Dr. Rosomoff does not, nor should he, guarantee future support for Industrial Engineering from the CPRC. Indeed, it is this committee's feeling that such heavy reliance upon extra-departmental funding for support of a Ph.D. program is ill-advised.

Overall, however, the Department of Industrial Engineering does not appear to be aggressive in obtaining active research grants, and the world does not appear to be beating its way to the department's door requesting the development of innovative research. The funding that the department has been successful in attracting appears to be adequate to maintain a master's degree program. However, this current level and type of funding falls far short of the active, highly-developed research that one expects for a doctoral degree program.

Overall Recommendation

Dr. Khalil repeatedly states in his support documents for this Ph.D. proposal that the establishment of a doctoral program in Industrial Engineering will help to strengthen the department by facilitating recruiting, and by increasing research funding from extramural sources. This subcommittee contends, however, that doctoral programs should be established in departments with proven strengths in research and academic excellence. Thus, it is our strong conviction that a doctoral program would be premature for Industrial Engineering. In a year or two, if they hire a nationally-recognized scholar in human factors, as well as one or two productive junior faculty members, the department may be ready to submit another proposal for our review. We do not, however, feel that such a program should be initiated with promises of future hiring and research development.



January 21, 1987

To: Dr. John Knoblock
Chairman, Faculty Senate

From: Dr. Tarek M. Khalil
Chairman, Industrial Engineering

As per your request during the last Faculty Senate Council meeting, I am enclosing herewith a plan for funding the Ph. D. program in the ergonomics area. As you can see from the enclosed attachments, current funding sources are supporting more than twelve graduate students. We expect that with the implementation of our Ph. D. program we can further expand our outside funding sources to accomodate more students and research faculty.

I am also enclosing another copy of faculty resumes for the benefit of the Senate Council members. I believe that our faculty's reputation and scholarly output in this area are indeed outstanding. I am quite confident that we can implement a strong Ph. D. program once the University approval is secured.

Attachments

TMK:dd

cc:Dean Norman G. Einspruch

Dr. S. Besvinick

Dept. of Industrial Engineering
College of Engineering
P.O. Box 248294
Coral Gables, Florida 33124
(305) 284-2344

EXHIBITS

Exhibit 1: Current Graduate Student Support (Ergonomics)

Exhibit 2: One Year Outside Grant Support for
Program Faculty (January 86-January 87)

Exhibit 3: Outside Grant Support for The Current
Fiscal Year (June 86 to present)

Exhibit 4: One Year Ergonomics Program Support through
the Comprehensive Pain and Rehabilitation
Center - South Shore Hospital and Department
of Neurological Surgery
(Fiscal year 1986-1987)

UNIVERSITY OF MIAMI
Department of Industrial Engineering
Current Graduate Student Support
(Ergonomics)

<u>Student Name</u>	<u>Amount</u>		<u>Source</u>
1. E.A. Moty (Res. Assoc.)	36,000	Stipend & tuition	CPRC*
2. Edwin Bon (Res. Assoc.)	30,000	Stipend & tuition	CPRC
3. S. Waly (Res. Asst.)	13,000	Stipend & tuition	CPRC
4. A. Zaki (Res. Asst.)	13,000	Stipend & tuition	CPRC
5. L. Melean (Res. Asst.)	8,135	Stipend	CPRC
6. Elaine Asfour (T.A.)	3,600	Stipend	UM (PT)
7. T. Bienkowski (R.A.)	6,000	Stipend & tuition	Burger King & UM
8. M. Tritar (R.A.)	6,000 6,408	Stipend & tuition	American Can Company
9. G. Duyos (R.A.)	6,000	Stipend tuition benefit	Frank B. Hall & UM
10. A. Genaidy	7,500	Stipend Full tuition Scholarship Egyptian Government	UM
11. S. Muthuswamy	6,700	Stipend & tuition	Release fund UM (Lab.Asst.)

* * * *

Additionally, the Department currently has four graduate Teaching Assistantships which pay both stipends and tuition. Two more Assistantships are budgeted under the weekend Executive Program. Faculty release time can support two to three additional graduate assistants.

At the present time, T.A. allocation and external funding sources are supporting 17 Graduate Assistants and a visiting assistant professor. A few more undergraduate students are supported as student assistants.

Several well qualified applicants have expressed their interest in the Department's Ph.D. Program. They are employed by local companies. They expect

* Comprehensive Pain and Rehabilitation Center

to pay full tuition for the program. It is estimated that about two to three applicants can be admitted under that arrangement. It is also expected that one or two additional international students can be paid full tuition and stipends through their Government Scholarship Funds.

The approval of the Ph.D. Program will encourage the Department to compete for training grants available from the National Institute for Occupational Safety and Health. These grants pay full tuition, stipends, faculty and program support. Our faculty have the reputation and the expertise to bid successfully for such a grant.

It is also expected that the initiation of a Ph.D. Program would stimulate added research support for faculty and graduate students.

ONE YEAR GRANT SUPPORT
FOR PROGRAM FACULTY
JANUARY 86 TO JANUARY 87
 (Round Figures)

MODCOMP		May 1986
(Equipment)	35,000	
(Training)	5,000	
IBM (Equipment)	30,000	January 1986
American Can	9,600	Asfour
Ryder System	7,500	Adaniya
SME	7,000	Rabie
Res Init	7,500	(matching fund \$7,500 provided by Dept.)
Phosphogypsum	15,000	Sumanth
Burger King	6,000	Khalil
Frank B. Hall	4,500	Khalil
NASA	100,000	Wiener*
	227,100	

* Dr. Wiener, a member of the faculty of the Department of Management Science, has a secondary appointment in Industrial Engineering. He is a member of the Ph.D. Program Committee and is a qualified and interested in the supervision of IEN Ph.D. dissertations.

GRANTS RECEIVED SINCE THE START OF FISCAL YEAR 86-87

(Round Figures)

American Can	\$7,000	Asfour
Ryder System	7,500	Adaniya
Allen Morris	6,000	Sumanth
Interamerican Bank	4,300	Khalil
Burger King	6,000	Khalil
Frank B. Hall	5,000	Khalil
Research Support	5,000	Omachonu
NASA	100,000	Wiener*
	<hr/>	
	\$140,800	

* Dr. Wiener, a member of the faculty of the Department of Management Science, has a secondary appointment in Industrial Engineering. He is a member of the Ph.D. Program Committee and is qualified and interested in the supervision of IEN Ph.D. dissertations.

PROGRAM SUPPORT
 ERGONOMICS IN REHABILITATION
 AND LOW BACK PAIN

Comprehensive Pain and Rehabilitation Center
 (June 1, 1986 - May 31, 1987)

<u>Name</u>	<u>\$ (round figures)</u>
T. M. Khalil, Ph.D.	17,000
S. Asfour, Ph.D.	17,000
M. Goldberg, Ph.D.*	26,000 (1/2 time @52,000)
E. Moty	36,000 (Ph. D. Candidate)
E. Bon	30,000 (M.S.I.E. Candidate)
S. Waly Candidate)	13,000 (M.S.I.E., Ph.D.)
A. Zaki	13,000 (M.S.I.E. Candidate)
L. Melean	8,100 (M.S.I.E., potential Ph. D. candidate)
	162,000

* Dr. Goldberg is a research Assistant Professor in the Department of Neurological Surgery. He is the clinical supervisor of the Ergonomics Division, CPRC. He spends at least 1/2 time in research applications and supervision of graduate students' work in Ergonomics.

SENATE COUNCIL MEETING

January 12, 1987

PRESENT: George Alexandrakis, William Awad, Jack Fell, Bruce Forman, Basil Honikman, John Knoblock, Chairman, Josephine Johnson, Daryl Ries, Alan Swan, and Kamal Yacoub.

ABSENT: Nicholas DeCarbo, and Donald Randolph.

ALTERNATES: Susan Seiler, and Harold Strauss.

GUESTS: Sidney Besvinick, Luis Glaser, Tarek Khalil, Harold Malt, J. Thomas Regan.

Call to Order and Approval of Minutes

The meeting was called to order at 2:00 P.M. by Dr. Knoblock. Excused absences were approved for Tony Harvell and Linda Neider. The minutes of the meetings of November 3, 17, and December 1 were approved as submitted.

School of Architecture's Land Development and Planning Proposal

Professor Harold Malt, School of Architecture, presented the rationale for the revised proposal for land development and planning. The proposal is now being considered as a bachelor of science degree rather than a bachelor of land development degree. It was moved, and seconded, to agenda the proposal for a first reading at the January 26 Faculty Senate meeting. Discussion followed. The motion carried by a vote of 9 in favor, 2 opposed, with one abstention.

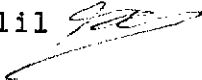
College of Engineering's Proposal for a Ph.D. in Industrial Engineering

Dr. Besvinick presented the recommendation of the Graduate Council regarding the College of Engineering's proposal for a Ph.D. in Industrial Engineering. Discussion followed concerning the funding and support for the proposed program. It was agreed that a program restricted to ergonomics may be feasible. Additional information was requested concerning the expected research level, teaching load levels, incremental costs associated with the students, support for student assistants, and the need for a technician.



January 9, 1987

To: Dr. John Knoblock

From: Dr. Tarek Khalil 

We have been fortunate through the personal efforts of Mr. Frank Rogers and Tom Rogero to make a detail comparison study of the holdings of the University of Miami in comparison with the holdings of Clemson University in the Industrial Engineering and it's related fields. As you can see, the University of Miami's holdings are much stronger than those of Clemson, which has had it's Ph. D. program in Industrial Engineering for several years.

Please consider this material as supplemental information to our previously submitted supporting material for the Ph. D. program in Industrial Engineering.

Enclosure
TMK/dd
cc:Dean Norman G. Einspruch
Mr. Frank Rogers

Dept. of Industrial Engineering
College of Engineering
PO. Box 248294
Coral Gables, Florida 33124
(305) 284-2344

COMPARISON OF HOLDINGS OF INDUSTRIAL ENGINEERING OR RELATED PERIODICAL TITLES
IN THE UNIVERISTY OF MIAMI LIBRARIES AND CLEMSON UNIVERSITY LIBRARY.

The following list of periodicals was submitted to the Director, Richter Library, by the Industrial Engineering Department, for a comparative analysis of holdings in the libraries of the University of Miami and Clemson University. The comparative study was done through the OCLC (Online Computer Library Center) Network. The result shows that the University of Miami libraries hold 94% of the titles as compared to 79% for the Clemson University Library.

"o" means no holdings in the libraries.
"H" means subscription held by the institution.

<u>Libraries</u>		<u>Titles</u>
<u>CU</u>	<u>UM</u>	
H	H	AIIE TRANSACTIONS.
H	H	ACADEMY OF MANAGEMENT. JOURNAL
H	H	ACADEMY OF MANAGEMENT. REVIEW.
O	H	ACCIDENT ANALYSIS AND PREVENTION.
H	H	ACOUSTICAL SOCIETY OF AMERICA. JOURNAL.
O	H	ACTA BIOTHEORETICA.
H	H	ACTA ORTHOPAEDICA SCANDINAVICA.
H	H	ACTA PHYSIOLOGICA SCANDINAVICA.
O	H	ADMINISTRATIVE SCIENCE QUARTERLY.
H	H	ADVANCES IN MARINE BIOLOGY.
H	H	AEROSPACE MEDICINE.
O	H	AEROSPACE SAFETY.
O	H	AGING AND HUMAN DEVELOPMENT.
H	H	AMERICAN ECONOMIC REVIEW AND SUPPLEMENTS.
H	H	AMERICAN HYGIENE ASSOCIATION JOURNAL.
H	H	AMERICAN JOURNAL OF AGRICULTURAL ECONOMICS.
O	H	AMERICAN JOURNAL OF INDUSTRIAL MEDICINE.
H	H	AMERICAN JOURNAL OF PHYSICAL ANTHROPOLOGY.
H	H	AMERICAN JOURNAL OF PSYCHOANALYSIS.
H	H	AMERICAN JOURNAL OF PSYCHOLOGY.
H	H	AMERICAN MACHINISTS.
H	H	AMERICAN SCIENTIST.
H	H	AMERICAN STATISTICAL ASSOCIATION. JOURNAL.
H	H	AMERICAN STATISTICAL ASSOCIATION. QUARTERLY PUBLICATIONS.
H	H	AMERICAN STATISTICAL ASSOCIATION. PUBLICATIONS.
H	H	AMERICAN STATISTICIAN.
H	H	ANNALS OF BIOMEDICAL ENGINEERING.
H	H	ANNALS OF HUMAN BIOLOGY.
H	H	ANNALS OF THE NEW YORK ACADEMY OF SCIENCE.
O	H	APPLIED ERGONOMICS.
O	H	APPLIED INDUSTRIAL HYGIENE.
O	H	ARMY RESEARCH AND DEVELOPMENT.
H	O	ARTIFICIAL LIMBS.

<u>Libraries</u>		<u>Titles</u>
CU	UM	ATMOSPHERIC ENVIRONMENT.
H	H	AUSTRALIAN JOURNAL OF PLANT PHYSIOLOGY.
H	H	AUSTRALIAN JOURNAL OF PSYCHOLOGY.
H	H	BEHAVIOR RESEARCH METHODS AND INSTRUMENTATION
H	O	AND COMPUTERS.
H	H	BELL JOURNAL OF ECONOMICS.
O	H	BELL JOURNAL OF ECONOMICS AND MANAGEMENT SCIENCE.
H	H	BIO SYSTEMS.
O	H	BIODYNAMICS.
H	O	BIOLOGICAL BULLETIN.
H	H	BIOPHYSICAL JOURNAL.
H	H	BIOPHYSICAL, BIOENGINEERING AND MEDICAL INSTRUMENTATION.
H	H	BIOTECHNOLOGY AND BIOENGINEERING.
O	H	BRAIN.
O	H	BRITISH JOURNAL OF INDUSTRIAL RELATIONS.
O	H	BRITISH JOURNAL OF PROJECTIVE PSYCHOLOGY AND
		PERSONALITY STUDY.
H	H	BULLETIN OF MATHEMATICAL BIOLOGY.
H	H	BUSINESS ECONOMICS.
H	H	BUSINESS HORIZONS.
H	H	CALIFORNIA MANAGEMENT REVIEW.
H	H	CHILTON'S IRON AGE.
O	H	COLUMBIA HUMAN RIGHTS LAW REVIEW.
H	H	COMPUTER DESIGN.
H	H	COMPUTERS AND BIOMEDICAL RESEARCH.
H	H	COMPUTERS AND GRAPHICS.
H	H	COMPUTERS AND INDUSTRIAL ENGINEERING.
H	H	COMPUTERS AND PEOPLE.
H	H	COMPUTERS AND THE HUMANITIES.
H	H	CONFERENCE BOARD REVIEW.
H	H	CREATIVE COMPUTING.
H	H	DECISION SCIENCES.
O	H	DISABLED U.S.A.
H	H	DISSERTATION ABSTRACTS.
H	H	ECONOMETRICA.
H	H	ECONOMIC JOURNAL.
O	H	ECONOMIC RECORD.
H	H	ELECTROENCEPHALOGRAPHY AND CLINICAL NEUROPHYSIOLOGY.
H	H	ENGINEERING ECONOMIST.
H	H	ENGINEERING MANAGEMENT INTERNATIONAL.
H	H	ENGINEERING MATERIALS AND DESIGN.
H	H	ENVIRONMENT.
H	H	ENVIRONMENTAL SCIENCE AND TECHNOLOGY.
H	H	ERGONOMICS.
H	O	ERGONOMICS ABSTRACTS.
H	H	EUROPEAN JOURNAL OF OPERATIONAL RESEARCH.
O	H	FEDERAL REGISTER.
H	H	FINANCIAL EXECUTIVE.

<u>CU</u>	<u>UM</u>	<u>Titles</u>
O	H	GEOGRAPHICAL ANALYSIS.
H	H	HARVARD BUSINESS REVIEW.
H	H	HUMAN BIOLOGY.
H	H	HUMAN DEVELOPMENT.
H	H	HUMAN FACTORS.
H	H	HUMAN RELATIONS.
H	H	IBM SYSTEMS JOURNAL.
H	H	IE: INDUSTRIAL ENGINEERING.
H	H	IEEE SPECTRUM.
H	H	IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING.
H	H	IIE TRANSACTIONS.
O	H	ILO INFORMATION.
O	H	ILO PUBLICATIONS.
O	H	ILLUMINATING ENGINEERING.
H	H	INDUSTRIAL AND LABOR RELATIONS REVIEW.
H	H	INDUSTRIAL DESIGN MAGAZINE.
H	H	INDUSTRIAL RELATIONS.
H	H	INDUSTRY WEEK.
H	H	INSTITUTION OF MECHANICAL ENGINEERS. PROCEEDINGS.
H	H	INTERFACES.
H	H	INTERNATIONAL ECONOMIC REVIEW.
H	H	INTERNATIONAL JOURNAL OF ENGINEERING SCIENCE.
H	H	INTERNATIONAL JOURNAL OF ENVIRONMENTAL STUDIES.
O	H	INTERNATIONAL JOURNAL OF MINI AND MICROCOMPUTERS.
H	H	INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH.
H	H	INTERNATIONAL JOURNAL OF ROBOTICS RESEARCH.
H	H	J O M. JOURNAL OF OCCUPATIONAL MEDICINE.
H	H	JAPANESE JOURNAL OF APPLIED PHYSICS.
H	H	JOURNAL OF ANATOMY.
O	H	JOURNAL OF ANALYTICAL PSYCHOLOGY.
H	H	JOURNAL OF APPLIED BEHAVIOR ANALYSIS.
H	H	JOURNAL OF APPLIED PSYCHOLOGY.
H	H	JOURNAL OF APPLIED PHYSIOLOGY.
H	H	JOURNAL OF AVIATION SPACE AND ENVIRONMENTAL MEDICINE.
H	H	JOURNAL OF BIOMECHANICS.
H	H	JOURNAL OF BIOMEDICAL MATERIALS RESEARCH.
H	H	JOURNAL OF BONE AND JOINT SURGERY.
H	H	JOURNAL OF BUSINESS.
H	H	JOURNAL OF ECONOMETRICS.
H	H	JOURNAL OF ECONOMIC LITERATURE.
H	H	JOURNAL OF ECONOMICS AND BUSINESS.
O	O	JOURNAL OF ENGINEERING PSYCHOLOGY.
H	H	JOURNAL OF ENGINEERING PHYSICS.
H	H	JOURNAL OF ENVIRONMENTAL, ECONOMICS AND MANAGEMENT.
H	H	JOURNAL OF ENVIRONMENTAL ENGINEERING.
O	H	JOURNAL OF EXPERIMENTAL PSYCHOLOGY.

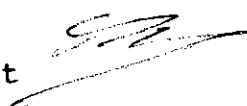
<u>Libraries</u>		<u>Titles</u>
<u>CU</u>	<u>UM</u>	
○	H	JOURNAL OF HUMAN ERGOLOGY.
○	H	JOURNAL OF HUMAN EVOLUTION.
H	H	JOURNAL OF HUMANISTIC PSYCHOLOGY.
H	H	JOURNAL OF INDUSTRIAL ECONOMICS.
H	○	JOURNAL OF INDUSTRIAL ENGINEERING.
H	○	JOURNAL OF INDUSTRIAL PSYCHOLOGY.
H	H	JOURNAL OF INDUSTRIAL RELATIONS.
○	H	JOURNAL OF MANUFACTURING SYSTEMS.
H	H	JOURNAL OF MARKETING.
H	H	JOURNAL OF MARKETING RESEARCH.
H	H	JOURNAL OF MEDICAL ENGINEERING AND TECHNOLOGY.
H	○	JOURNAL OF METHODS-TIME MEASUREMENTS.
H	H	JOURNAL OF MONEY, CREDIT AND BANKING.
H	H	JOURNAL OF OCCUPATIONAL MEDICINE.
○	H	JOURNAL OF OCCUPATIONAL PSYCHOLOGY.
H	H	JOURNAL OF PHYSIOLOGY.
○	H	JOURNAL OF PLANNING AND ENVIRONMENTAL LAW.
H	H	JOURNAL OF REGIONAL SCIENCE.
H	H	JOURNAL OF RETAILING.
H	H	JOURNAL OF SAFETY RESEARCH.
H	H	JOURNAL OF SPEECH AND HEARING DISORDERS.
H	H	JOURNAL OF SYSTEMS MANAGEMENT.
H	H	JOURNAL OF THE AMERICAN INSTITUTE OF PLANNERS.
H	H	JOURNAL OF THEORETICAL BIOLOGY.
H	H	LANCET.
H	○	LOGISTICS AND TRANSPORTATION REVIEW.
H	H	MANAGEMENT ACCOUNTING.
H	H	MANAGEMENT FOCUS.
H	H	MANAGEMENT REVIEW.
○	H	MANAGEMENT SERVICES.
H	H	MANAGEMENT SCIENCE.
○	H	MANUFACTURING PRODUCTIVITY FRONTIERS.
H	H	MATERIAL FLOW.
○	H	MATERIALS HANDLING NEWS.
H	H	MATHEMATICAL PROGRAMMING.
H	H	MEDICAL AND BIOLOGICAL ENGINEERING AND COMPUTING.
H	H	MEDICAL JOURNAL OF AUSTRALIA.
H	H	MEDICAL RESEARCH ENGINEERING.
H	H	MINI-MICRO SYSTEMS.
H	H	MINING ENGINEERING
○	H	MINING JOURNAL.
H	H	MODERN CASTING.
H	H	MODERN MATERIALS HANDLING.
H	H	MODERN PLASTICS.
H	H	MONTHLY LABOR REVIEW.
H	H	NATURE.
H	H	NAVAL RESEARCH LOGISTICS QUARTERLY.
H	H	NEW SCIENTIST.
○	○	NEWSLETTER, PROSTHETICS AND ORTHOTICS CLINIC.

<u>CU</u>	<u>Libraries</u>	<u>UM</u>	<u>Titles</u>
H		H	NETWORKS.
H		H	O E C D OBSERVER.
H		H	OCCUPATIONAL HAZARDS.
H		H	OPERATIONAL RESEARCH SOCIETY. JOURNAL.
H		H	OPERATIONS RESEARCH.
O		H	OPERATIONS RESEARCH SOCIETY OF AMERICA. BULLETIN.
H		H	OPERATIONS RESEARCH SOCIETY OF AMERICA. ORSA/TIMS BULLETIN.
H		H	ORGANIZATIONAL DYNAMICS.
H		H	PERCEPTUAL AND MOTOR SKILLS.
O		H	PERSONNEL.
H		H	PERSONNEL PSYCHOLOGY.
H		H	PHYSICAL THERAPY.
H		H	PHYSIOLOGICAL REVIEWS.
H		H	PROCEEDINGS OF THE ROYAL SOCIETY.
H		H	PRODUCTION ENGINEERING.
O		O	PRODUCTIVITY MEASUREMENT REVIEW. (ceased 1965)
O		H	PRODUCTIVITY PERSPECTIVES.
H		O	PROFESSIONAL SAFETY.
H		H	PUBLIC ADMINISTRATION REVIEW.
H		H	QUALITY PROGRESS.
H		H	REHABILITATION COUNCELING BULLETIN.
H		H	REHABILITATION LITERATURE.
H		O	REHABILITATION RECORD.
O		H	REMOTE SENSING OF ENVIRONMENT.
H		H	RESEARCH MANAGEMENT.
O		H	RESEARCH QUARTERLY FOR EXERCISE AND SPORT.
H		H	REVIEW OF ECONOMICS AND STATISTICS.
O		H	REVIEW OF INCOME AND HEALTH.
O		H	ROBOTICS.
H		H	ROBOTICS AGE
H		H	ROBOTICS AND COMPUTERS.
H		H	ROBOTICS TODAY.
H		H	ROYAL STATISTICAL SOCIETY. JOURNAL. SERIES A.
H		H	ROYAL STATISTICAL SOCIETY. JOURNAL. SERIES B.
H		H	ROYAL STATISTICAL SOCIETY. JOURNAL. SERIES C.
H		H	SIAM JOURNAL OF APPLIED MATHERMATICS.
H		H	SIAM REVIEW.
H		H	SALES AND MARKETING MANAGEMENT.
O		H	SCANDINAVIAN JOURNAL OF REHABILITATION MEDICINE.
H		H	SCIENTIFIC AMERICAN.
H		H	SLOAN MANAGEMENT REVIEW.
H		H	SMALL GROUP BEHAVIOR.
H		H	SOCIO-ECONOMIC PLANNING SCIENCES.
H		H	SOUTHERN ECONOMIC JOURNAL.
H		H	SUPERVISORY MANAGEMENT.
H		H	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE.
H		H	TEXTILE WORLD.
O		H	TOOLING AND PRODUCTION.
H		H	TRANSPORTATION RESEARCH, PTS. A & B.
H		H	TRANSPORTATION SCIENCE.



December 29, 1986

To: Professor John Knoblock

From: Tarek M. Khalil
Chairman, IE Department 

Subject: Ph. D. in Industrial Engineering

As per your request during our meeting earlier this month, I am enclosing herewith the comparative materials with some private universities offering the Ph. D. program in Industrial Engineering. I hope that this material together with our initial proposal documentation would satisfy the Senate Council's needs. Of course, I will be available to answer any questions the Council may have during the meeting.

I look forward to the Senate's favorable response soon.

Enclosures
TMK/dd
cc:Dean Norman G. Einspruch

Dept. of Industrial Engineering
College of Engineering
P.O. Box 248294
Coral Gables, Florida 33124
(305) 284-2344

UM Industrial Engineering Ph.D. Program

Comparative Materials

1) The University of Miami Program

The University of Miami Ph.D. program concentrates on two important areas of Industrial Engineering, namely: 1) Ergonomics and 2) Production Systems Engineering. The Ergonomics area is closely allied with the fields of Psychology, Physiology, Anatomy, Epidemiology and Engineering. The University of Miami offerings in this area and in collateral fields are extremely powerful both in the Industrial Engineering Department as well as in the supporting Departments.

The Production Systems Engineering area is closely allied with the fields of Management Science, General Business Organizations, Economics, Mathematics, Computer Science and Engineering. Again, the University of Miami offerings in these areas are strong. Excellent collateral field support exists. The Department offers a number of good courses and intends to further strengthen its offerings with the addition of another experienced faculty member in this area.

Pages 19 and Appendix III of the original proposal details courses available in the Industrial Engineering Department and in collateral field. Addendum I provides a more updated curriculum plan for the two tracks of the Ph.D. program.

2) Faculty

The University of Miami faculty in the Ergonomics track have both excellent experience and international reputation. In my opinion their strength is matched only by less than a handful of other universities in the entire country. These are the University of Michigan and Texas Tech, North Carolina State and Auburn.

This judgement is based on faculty scholarly output, awards and involvement in national professional activities.

In the area of Production Systems Engineering the University of Miami has a number of young aggressive, well qualified faculty members. Their scholarly output has been on the increase.

Dr. Sumanth has already published a book and several papers and Dr. Moder (in a supporting capacity) is internationally

known. Dr. Khalil and Dr. Bayraktar (visiting status) have extensive experience in the field. Supporting Department faculty in the School of Business Administration and Engineering are certainly very well qualified.

The University of Miami Industrial Engineering Department faculty number has reached the critical mass that is capable of supporting the Ph.D. program.

3) A. Library

It is somewhat difficult to exactly compare Library resources or for that matter other resources with those at a compatible private institution for the simple reason that the ones the University of Miami usually compares itself with do not have an Industrial Engineering Ph.D. program. These are Washington University, Tulane, Emory, Duke and Vanderbilt.

From a list that was prepared by the Industrial Engineering Department faculty of all titles that were considered relevant to the Ph.D. program in Industrial Engineering, the University of Miami Library has better than 84% of them (page 10 and Appendix IV of Ph.D. proposal). Many new titles have been acquired since the time of the preparation of the original proposal in 1984.

B. Laboratories

Laboratory resources at the University of Miami compares well in the areas of computer support and in Ergonomics. The recent grants to the College of Engineering and the Department of Industrial Engineering in equipment and computers gave the Department access to some of the most modern computer facilities.

The Department of Industrial Engineering Ergonomics Laboratories and the Medical School facilities provide the Department with excellent Ergonomics research capabilities.

Course Offering
Production Systems Engineering

<u>Emphasis</u>	<u>UM</u>	<u>USC</u>	<u>Stanford</u>	<u>Lehigh</u>
	<u>Production</u>	<u>O.R.,H.F.,Production System</u>	<u>Management&Prod.Sys</u>	<u>Manufacturing</u>
	Computer Simul. Adv. IE Concept. Design of Exp. Appl. O.R. Prod. Mst.&Eval. Advanced Simul. Prod.Sys Analysis & Designs Adv. Matl. Handling & Facilities Adv. Robotics Proan Planning Non Linear & Dyn Programming Integrated Progr. Stochastic Procen. Quenering Mod.	Eng. Analysis of Mfg Enterprise Intro to Sys in IE Math Methods for O.R. O. R. I O. R. II Adv Topics in Work MST. Sys. Eng. Meth. Adv.Eng. Economy Simulations of IE Systems Technological Forecasting Stochastics Processes Modeling & Simulation	Organizational Behav & Mgt. R&D Management The Firm in the Int. & Economy Eval. of Ind. Projects of Prod Analysis of Prod Sys I Analysis of Prod. Sys II Analysis of Prod. Sys III New Enterprise Mgt.	Mfg. Mgt. Automation and Production Sys. Manufacturing Problems Data Base Mgt. Math Methods in O.R. Mgt. Inf. Syst. Simulation Adv. Work Systems Adv.Math Prog. Adv. Work Sys.

Course Offering

Ergonomics

UM	USC	Stanford	Lehigh
Man-Mach. System Ind. Hygiene Work Physiology Ergonomics and Occupational Biomech. Ind. Hygiene Lab Accident Prev. Sys. Intro to Biomed. Inst. Design of Experiments Fund. of Epidermidology Non Parametric Stat. Adv. Seminar in Ergo	HF in Engineering HF in Eng. Design	Man Machine Systems Industrial Engineering Problems	Design of Experiments

Faculty

	UM	USC	Stanford	Lehigh	RPI	Clemson
Professors	3	3	4	5	1	4
Assoc.	3	1	2	4	6	2
Asst.	6	7	2	4	3	1
Adjunct	2	-	1	-	-	-
Secretaries	2 1/2	4	7	2+2soft	3	2
Research Support	200K	300K	N/A	500k	150k	25k



<u>School</u>	<u>Faculty Size</u>	<u>Year</u>	<u>Ph.D Degrees</u>	<u>Areas of Research</u>
<u>Florida</u>	16	82-83	3	Mfg. Systems, Network location, Traffic Assign
		84-85	2	
<u>Central FL</u>	14*	82-83	0	Program awarded December 1981
		84-85	1	
<u>South FL</u>	8	84-85	0	Program awarded January 1982
			0	

*Split into two departments in 1985

UNIVERSITIES OFFERING PH.D. PROGRAMS IN INDUSTRIAL ENGINEERING

School	Faculty Size	Ph.D. Enrollment Fall 1983	Ph.D. Degrees 1982-83	Areas of Ph.D. Research 1982-83
1) Alabama - Huntsville	5	7	1	Operation Research
2) Arizona State	18	21	3	Computer Aided Systems, Integrated Systems, Manpower Sched
3) Arizona	12	10	5	Production, QC, Math Prog., Nonlinear Syst., Image Proc.
4) Arkansas	15	4	0	O.R., Robotics
5) Auburn	26	11	0	Ergonomics Safety, Simulation
6) Cal. Berkeley	14	41	8	O.R.
7) Central Florida	14	15	0	-
8) Clemson	4	5	0	O.R.
9) Columbia	12	20	3	Industrial Economics, Reliability
10) Cornell	19	44	5	Applied Prob. Inventory Control, Math. Proc. Optim.
11) Florida	16	13	3	Manuf. Systems, Network Location, Traffic Assignment
12) George Wash.	18	80	5	Eng. Administration, O.R.
13) Georgia Tech	39	45	9	O.R., Production, Prob. Stat, Mat. Hdng.
14) Houston	10	4	0	O.R., Estimation Theory, Computer Languages
15) Illinois	N/A	-	0	O.R., Production
16) Iowa State	26	10	1	Optimization, Inventory, Human Factors, Management
17) Iowa	7	9	1	Simulation
18) Kansas State	11	6	0	Human Factors, Manufacturing
19) Lehigh	11	7	2	Statistics, Facility Location
20) La. Tech	6	4	0	-
21) Mass	13	32	1	Prod. Planning, Optim., Human Factors
22) Michigan	18	39	4	O.R.
23) Minnesota	?	2	0	-
24) Miss. State	7	1	0	-

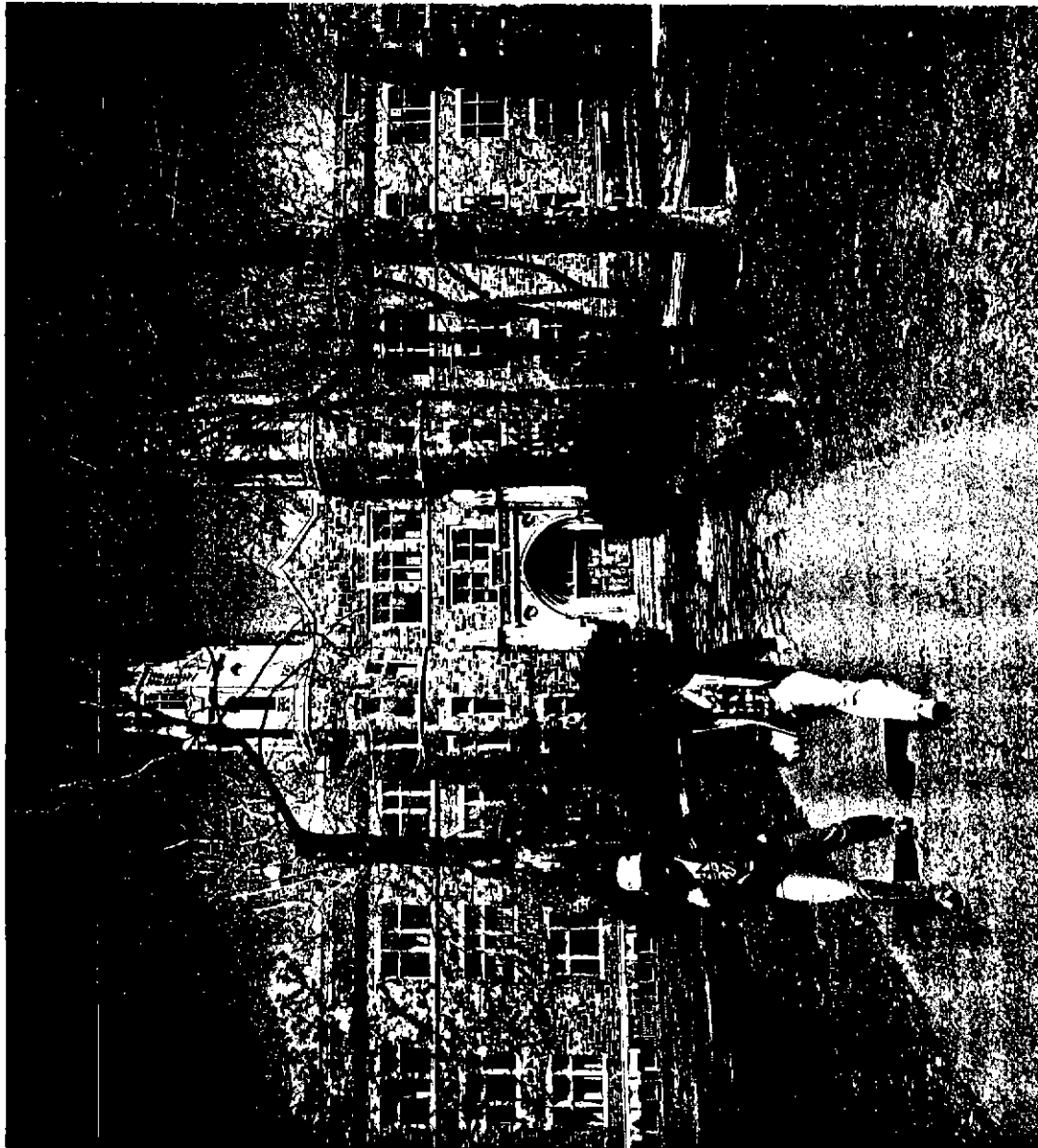
UNIVERSITIES OFFERING PH.D. PROGRAMS IN INDUSTRIAL ENGINEERING (CONT'D.)

School	Faculty Size	Ph.D. Enrollment Fall 1983	Ph.D. Degrees 1982-83	Areas of Ph.D. Research 1982-83
25) Missouri	9	4	2	Risk Management
26) Missouri-Rolla	11	9	0	Engineering Management
27) Nebraska	8	16	1	Operations Research
28) SUNY	7	33	3	Job Performance, Integer Prog.
29) N.C.State	20	41	6	Stochastic Models, Lot Sizing, Optimal Replacement
30) Northwestern	14	33	7	Operations Research
31) Ohio State	16	47	4	Manufacturing, Statistics, O.R.
32) Oklahoma State	12	19	3	Statistics, O.R., Management
33) Oklahoma	8	14	0	-
34) Oregon State	8	5	3	Productivity, Statistics
35) Penn State	16	18	7	Operations Research
36) Pitt	10	16	2	Operations Research in Health Systems
37) Poly. Inst. of N.Y.	12	15	3	Operations Research
38) Purdue	22	52	10	Manuf., O.R., Production, Human Factors
39) Rutgers	7	1	0	-
40) South Florida	8	7	0	-
41) Southern Cal.	9	11	3	Simulation, Q.C., Human Factors
42) SMU	12	15	0	-
43) Stanford	9	9	1	-
44) Syracuse	7	9	0	-
45) Texas A&M	20	54	6	Human Factors, Simulation, Systems Analysis, Reliability
46) Texas Tech	10	16	3	O.R., Ergonomics
47) Texas-Arlington	8	12	1	Injury Study
48) VPI	25	48	10	Human Factors, Manuf., O.R.

FEB 28 1984

COLLEGE OF ENGINEERING

Graduate Study In Industrial Engineering



Lehigh University

Doctor of Philosophy

The doctor of philosophy program is organized to meet the goals and interests of students who plan to engage in teaching, consulting, or research activities in industry, government or education.

The objective of the program is to educate these students to perform their respective activities at a high level of proficiency. Each doctoral student is required to: demonstrate competency in several broad fields of industrial engineering related to his or her area of interest; prepare, through formal coursework and independent study for examination by members of the graduate faculty in an area of specialization; and present a dissertation related to the field of specialization that embodies the results of original research, shows evidence of high scholarship, and constitutes a contribution to knowledge.

A typical program consists of three years of full-time study beyond the bachelor degree (two years of coursework plus one year of research) or two years beyond the master's degree (one year of coursework plus one year of research). After completion of about one year of study, the doctoral student is required to take a "qualifying examination," which assures that students have sufficient breadth of knowledge and technical competency prior to doctoral candidacy. During the dissertation research, and usually after all coursework is completed, a "general examination" is administered to test the candidate's capacity and proficiency in the particular field of study.

Finally, the candidate is required to present a dissertation representative of original research and to defend the research orally in a "final examination." No foreign language is required of Ph.D. candidates in industrial engineering.

Further information about the doctor of philosophy program at Lehigh is contained in the Graduate School section of the university catalog and in a brochure prepared by the department of industrial engineering entitled, "The Ph.D. Program in Industrial Engineering."

Research Interests

Recent master of science and doctor of philosophy research includes the following.

Master's theses

Computer-aided methods for determining drilling sequences of non-turret, multiple spindle, numerical-control drilling machines
Evaluation of indirect work by multiple regression

Economic lot sizes in a multi-state production-inventory system

An investigation of the use of remote thermocouple cutting tool temperatures to predict tool wear

An investigation into the application and development of GERTS III R in the resource allocation problem

The development of an interactive data base system for machinability data

A model for the evaluation of techniques for seasonal adjustment of economic time series

A comparison of time-sharing and batch processing through an analysis of programming errors

An investigation of aggregate planning and master production scheduling for the case of multiple product families

A drug information module for a computerized pharmacy subsystem

Integrated testing methodology for system development projects

Guidelines for improving user/DP relations in the information processing environment

Ph.D. dissertations

A dynamic systems model and general theory of crime control

A model for increasing the effectiveness of manpower training decisions in a complex dynamic environment

"The master of engineering degree is most appropriate for practicing engineers who are interested in achieving breadth, rather than depth, of coverage of the discipline(s)."

"The university's computer network is comprehensive and fully supports the wide range of industrial engineering-related application areas."

An investigation to determine tool life in terms of surface roughness and size variation
Analysis and synthesis of multi-echelon inventory systems using the theory of feedback control systems

The micro-scheduling of computer jobs
The capacity-design and scheduling of soaking pits

A computer-assisted system for the generation of machining parameters in a job shop

An investigation of analytic procedures and numerical implementation for the solution of GERT networks

Application of graph coloring approach to a timetabling problem

IBM operating system. Using terminals in this laboratory, students develop data acquisition and process control software for coursework and research projects.

The industrial engineering department has acquired a work systems simulator to be used for both instruction and research. Designed and built under the direction of department faculty, the simulator is driven by a microprocessor and represents an advanced approach to the analysis of modern work systems.

The IS laboratory provides classroom and project team space as well as a terminal room. The terminal room is equipped with six intelligent CRT terminals and two intelligent hard-copy terminals. All terminals are capable of utilizing all computers of the Lehigh University Computing Center. The Center's computer network is comprehensive and fully supports the wide range of industrial engineering-related application areas.

The university's Mart Science and Engineering Library contains 150,000 volumes in the fields of engineering, mathematics, and the natural and physical sciences; it also subscribes to over 2,000 serials and periodicals. The university library system, including Mart and Linderman libraries, contains 730,000 volumes. There are 8,500 serials, of which 5,900 represent current periodicals.

Facilities

The offices and laboratories of the department are located in the James Ward Packard Laboratory. Available for graduate study and research within the department are a modern metal processing research laboratory, computer-aided manufacturing (CAM) laboratory and information systems (IS) laboratory.

The metal processing laboratory contains machine tools used for research in milling, drilling, and turning-type operations. In addition, numerically controlled machine tools support testing and research in this area. Instrumentation includes devices for measurement of cutting forces, surface finish, tool wear and related variables.

The CAM laboratory is used in conjunction with the metal processing laboratory. It contains a Digital Equipment Corporation PDP 11/34 computer system with double disk and the RSX-

Faculty and Their Interests

John W. Adams (Ph.D., North Carolina), associate professor (statistics, operations research)

Arthur F. Gould (M.S., Lehigh), professor and associate dean, College of Engineering and Physical Sciences (operations analysis, production and inventory systems)

Mikell P. Groover (Ph.D., Lehigh), professor and director of the manufacturing processes laboratory (manufacturing engineering, production systems)

George E. Kane (M.S., Lehigh), professor and department chairman (manufacturing engineering, manufacturing processes)

John R. Krobock (M.S.E., Arizona State University), associate professor (information systems, systems engineering)

Larry E. Long (Ph.D., Oklahoma), associate professor (information systems, engineering economy)

Sutton Monro (B.S., Massachusetts Institute of Technology), professor (statistics)

Louis J. Plebani, Jr. (Ph.D., Lehigh), assistant professor (operations research)

Wallace J. Richardson (M.S., Purdue), professor (work systems, information systems)

Ben L. Wechsler (Ph.D., Lehigh), professor and director of the university computing center (systems engineering, information systems)

George R. Wilson (Ph.D., Pennsylvania State University), assistant professor (operations research)

Emory W. Zimmers, Jr. (Ph.D., Lehigh), professor and director of the computer-aided manufacturing laboratory (manufacturing systems)

Course Offerings

The following courses are for advanced undergraduates and graduates.

- 205. Engineering Statistics (3)**
Application of point and confidence interval estimation and hypothesis testing to the fitting of frequency and regression models, to acceptance and control sampling and to elementary design of experiments. Prerequisite: IE 110 or Math 231 or equivalent.
- 206. Operations Research Techniques (4)**
The development and use of the elementary techniques of operations research. Topics include linear programming, queuing theory, probabilistic inventory models, simulation, and decision analysis. Prerequisites: IE 110 or Math 231.
- 212. Elementary Design of Experiments (3)**
An introduction to the structure of experiments, the analysis of experimental data, and their interrelation. Measurement error, randomization, pairs and blocks, regression, and analysis of variance. Prerequisite: graduate standing or consent of the department chairman.
- 300. Apprentice Teaching in IE (1-3)**
- 307. Information Systems Analysis (3)**
Study of advanced techniques and their application in the analysis and design of information systems. The course emphasis is on the tools and techniques used for structured systems analysis and design. Prerequisite: IE 18 or equivalent.
- 309. Information Systems Development (3)**
Study of information systems development to include design, implementation, evaluation and management. Introduction to data structure concepts, their use in the production of information for an organization, and their effects on organizational relationships. Students conduct a feasibility study for an information system. Prerequisite: IE 18 or Acctg 111 or equivalent.
- 310. File Structure and Processing (3)**
Study of data structures and file organization for effective processing by computer to include storage management and generation, update, sorting, searching, and query techniques using COBOL. Introduction to data base design and data base management systems. Prerequisite: IE 309 or Acctg 311 or equivalent.



These students are at work in the computer-aided manufacturing laboratory.

408. (Acctg 408). Management Information Systems (3)
Philosophies, concepts and methods for systematic planning, development, and implementation of management information systems (MIS). Various methods and approaches to automation of major MIS subsystems. Concepts in computer center organization. Long range planning for management information systems. Topics related to efficient and effective management of corporate computer centers. Prerequisite: IE 309 or Acctg 311 or equivalent.

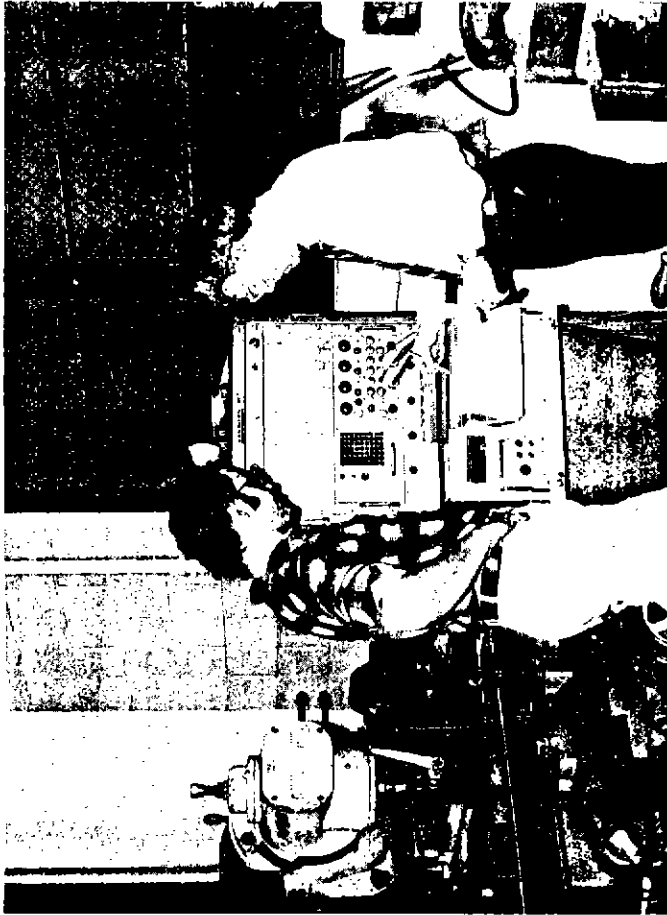
410. Design of Experiments (3)
Experimental procedures for sorting out important causal variables, finding optimum conditions, continuously improving processes, and trouble shooting. Applications to laboratory, pilot plant and factory. Prerequisites: Some statistical background and experimentation in prospect.

415. Manufacturing Management (3)
Analysis of the factors entering into the development of manufacturing management philosophy; decision-making process in areas of organization, planning, operation, and control of manufacturing. Influence of the social, technical, and economic environment upon manufacturing management decisions.

416. Dynamic Programming (3)
The principal of optimality; one-dimensional processes, multidimensional processes, LaGrange multiplier technique; Markovian decision processes; applications.

417. (Mgt 417) Advanced Mathematical Programming (3)
Theory and applications of the extensions of linear programming. Kuhn-Tucker conditions, gradient methods of optimization, simplex-based methods, nonlinear programming, integer programming, branch and bound, zero-one discrete programming and stochastic programming. Prerequisite: a course in linear programming.

418. Simulation (3)
Application of discrete and continuous simulation techniques to model industrial systems; random number generation and testing; design of simulation experiments; simulation languages. Prerequisite: knowledge of FORTRAN and a course in probability theory.



Professor Mikell P. Groover discusses the results of a milling experiment with a student in his lab.

419. Sequencing and Scheduling (3)
A study of sequencing and scheduling problems and models. Specific topics addressed are simple and parallel machine models, flow shop scheduling, analytic and simulation approaches to job shop scheduling, and extensions to resource constrained project scheduling. Prerequisite: IE 315 or consent of instructor.

428. Advanced Work Systems (3)
A critical evaluation of methods improvement and work measurement techniques. Emphasis on design of work systems, productivity improvements, and reporting systems to control work. Work sampling, construction of standard data, mathematical models of work systems.

430. (Mgt 430) Management Science Project (3)
An analysis of a management problem and design of its solution incorporating management science techniques. An individual written report is required. Recommended to be taken in the last semester of the program.



Prof. Wallace J. Richardson and a graduate student work at the computer-controlled work simulator in the work systems laboratory.

- 431. Operations Research Seminar (3)**
Extensive study of selected topics in techniques and models of operations research.
- 433. Manufacturing Engineering Seminar (3)**
Extensive study of selected topics in the research and development of manufacturing engineering techniques.
- 435. Mathematical Methods In Operations Research (3)**
The fitting of data using splines and polynomials. The use of differential equations, difference equations, Laplace transforms, generating functions and matrices in the solution of problems arising in scheduling, inventories, maintenance, queuing and replacement. Prerequisites: calculus, linear algebra, knowledge of FORTRAN or equivalent.
- 437. Data Base Management Systems (3)**
An intensive treatment of modern data base technology to include logical and physical organization of data bases, control of redundancy, commercially available data base management systems and systems selection methodology. Course includes a design project. Prerequisite: an advanced course in file structures and processing.
- 438. Design of Communications-based Information Systems (3)**
Concepts and types of communications-based (online) information systems. Presentation of the methodology and techniques used for information system development and design as it relates specifically to online systems. Examination of the state-of-the-art of support hardware and software for online systems. Prerequisite: IE 310 or consent of the department chairman.
- 439. Applications of Stochastic Processes (3)**
Introduction to stochastic processes, application in queueing theory and inventory theory. Prerequisites: a course in probability theory and IE 435.
- 443. Automation and Production Systems (3)**
Concepts and principles of automated production lines; analysis of transfer lines; partial automation; mechanized assembly systems; flexible manufacturing systems; industrial robots; line balancing; product and process design considerations.

- 444. Design of Cutting Tools (3)**
A study of design parameters including tool materials, tool geometry, and cutting conditions for material removal operations. Emphasis will be placed on influence of tool selection variables, on economy of operations and conformance to product requirements.
- 449. Advanced Computer-Aided Manufacturing (3)**
Numerical control in manufacturing; CAD/CAM systems; computer monitoring and control of manufacturing operations; adaptive control and other techniques of process optimization. Manufacturing resource planning, computer-aided process planning, and shop floor control. Prerequisite: IE 342 or consent of instructor.
- 450. Manufacturing Problems (3)**
Discussion and solution of manufacturing problems involving several subfunctions, with emphasis on problem identification and definition; selection of techniques of analysis; procedures for evaluation of proposed solutions.
- 460. Engineering Project (1-6)**
An intensive study of an area of industrial engineering with emphasis upon design and application. A written report is required.
- 461. Readings (1-3)**
Intensive study of some area of industrial engineering which is not covered in general courses.
- 490. Research Methods Seminar (3)**
Research methods in industrial engineering; discussion and critical analysis of current industrial engineering research; practice in preparation of research proposals.

BULLETIN OF THE
UNIVERSITY OF SOUTHERN CALIFORNIA

THE GRADUATE SCHOOL

General Information / Degrees and Requirements / Courses of Instruction

ENGINEERING

INDUSTRIAL AND SYSTEMS ENGINEERING

Professors: CLINTON J. ANCKER, JR., Ph.D., P.E. (*Chairman*); GERALD A. FLEISCHER, Ph.D., P.E.

Adjunct Professors: HOWARD LAITIN, Ph.D.; HARRY WOLBERS, Ph.D.

Associate Professors: L. ROBERT SCHRUBEN, M.S.; C. WILSON WHITSTON, I.E., P.E.

Adjunct Associate Professors: WALTER GOFT, Ed.D.; DON LeBELL, Ph.D.

Assistant Professors: DAVID L. JAQUETTE, Ph.D.; BENNETT P. LIENTZ, Ph.D.

Lecturers: ROBERT H. CREMER, Ph.D.; JAMES G. GAUME, M.D.; WILLIAM GIROUARD, M.S.; SIDNEY MOGLEVER, M.S.; SHAHPOUR PARTOVI, Ph.D.; JONATHAN YORKMARK, Ph.D.

420 PROBABILITY CONCEPTS IN ENGINEERING (4)

425 ENGINEERING STATISTICS I (4)

430 INTRODUCTION TO OPERATIONS RESEARCH (4)

460 ENGINEERING ECONOMY (3)

463 FACILITIES ANALYSIS AND DESIGN (4)

477 WORK ANALYSIS AND DESIGN (4)

482 INTRODUCTION TO COMPUTERS AND PROGRAMMING TECHNIQUES (3)

490 SPECIAL PROBLEMS (1-3, maximum 6) Graded pass/—.

498 PROSEMINAR (1)

499abc PREPARATION FOR GRADUATE STUDY IN INDUSTRIAL AND SYSTEMS ENGINEERING (2-2-2)

510 ENGINEERING ANALYSIS OF A MANUFACTURING ENTERPRISE (3)

515 INTRODUCTION TO SYSTEMS IN INDUSTRIAL ENGINEERING (3)

520 MATHEMATICAL METHODS FOR OPERATIONS RESEARCH TECHNIQUES IN ENGINEERING (3)

525 INTERMEDIATE ENGINEERING STATISTICS II (3)

526 ADVANCED STATISTICAL ASPECTS OF ENGINEERING RELIABILITY (3)

530 OPERATIONS RESEARCH I (3)

531 OPERATIONS RESEARCH II (3)

540 ADVANCED TOPICS IN WORK MEASUREMENT AND METHODS ANALYSIS (3)

541 SYSTEMS ENGINEERING METHODOLOGY (3)

550 SEMINAR (2, maximum 4)

561 ADVANCED ENGINEERING ECONOMY (3)

COURSES OF INSTRUCTION

562 VALUE AND DECISION THEORY. (3)

570 HUMAN FACTORS IN ENGINEERING (3)

571 HUMAN FACTORS IN ENGINEERING DESIGN (3)

575 SYSTEMS CONTROL THEORY (3)

580 SIMULATION OF INDUSTRIAL ENGINEERING SYSTEMS (3)

585 TECHNOLOGICAL FORECASTING (3)

590 DIRECTED RESEARCH (1-12) Graded pass/—.

494ab THESIS (2-2) Graded pass/—.

598ab INTERDISCIPLINARY SEMINAR FOR INTERNATIONAL DEVELOPMENT (2-2)

599 INTERDISCIPLINARY SEMINAR FOR INTERNATIONAL DEVELOPMENT (FIELD WORK) (8)

630 STOCHASTIC PROCESSES IN INDUSTRIAL AND SYSTEMS ENGINEERING (3)

650abcd SEMINAR (1/2, 1/2, 1/2, 1/2)

680 MODELING AND SIMULATION IN INDUSTRIAL ENGINEERING (3)

685 SEMINAR IN ADVANCED TOPICS IN INDUSTRIAL ENGINEERING (2, maximum 4)

690 DIRECTED RESEARCH (1-4, maximum 8) Graded pass/—.

694ab THESIS (1-2—1-2) Graded pass/—.

For Ph.D. courses 790 and 794abcd, see page 157.

MATERIALS SCIENCE

Professors: CLARENCE R. CROWELL, Ph.D.; MURRAY GERSENZON, Ph.D.; FERDINAND A. KRÖGER, Ph.D. (*Chairman*); JAN SMIT, Ph.D.; WILLIAM G. SPITZER, Ph.D.; JAMES M. WHELAN, Ph.D.; DAVID B. WITTRY, Ph.D.

Associate Professors: JAMES R. CADY, Ph.D., P.E.; STEPHEN M. COPLEY, Ph.D.; TERENCE G. LANGDON, Ph.D.; WILLIAM R. WILCOX, Ph.D.

Assistant Professors: JOHN P. HURRELL, Ph.D.; KENNETH M. LAKIN, Ph.D.; RONG WANG, Ph.D.

Research Associates: AMIN DEGANI, Ph.D.; AGERICO ESQUIVEL, Ph.D.; ERIC S. JOHNSON, Ph.D.; HARI NARAYANAN, Ph.D.

Lecturers: WORTH P. ALLRED, M.S.; SIDNEY A. WIELIN, B.S.

501 CRYSTAL DYNAMICS (3)

ADVANCED METALLOGRAPHY (3) (Enroll in M.E. 501L)

502 BAND THEORY OF SOLIDS (3)

search. Topics may include areas of theory as well as areas of applications. Topics will be announced on a quarterly basis. In 1980-81 the following 3-unit seminars were held: Seminar on Information Policy (Dunn) and Seminar in Medical Policy Analysis (Eddy and Oren).

1 or more units, Aut, Win, Spr (Staff) by arrangement

INDUSTRIAL AND ENGINEERING MANAGEMENT

Emeritus: Eugene L. Grant, W. Grant Ireson,
Robert V. Oakford (*Professors*)

Chairman: Henry E. Riggs

Professors: James L. Adams, Warren H. Hausman, Henry E. Riggs, David A. Thompson
Associate Professors: Robert C. Carlson, James V. Jucker

Adjunct Professors: Robert McGinn

Assistant Professors: Kathleen M. Eisenhardt,
James E. Hodder

Lecturer: Charles F. Bané

Affiliated Faculty: Professors: Frederick S. Hillier, Charles A. Holloway, Douglass J. Wilde, Richard S. Shevell, Arthur F. Veinott, Steven C. Wheelwright

By Courtesy: Gayton E. Germane. *Consulting:*
Stewart P. Blake

PROGRAMS OF STUDY

Industrial Engineering is concerned with how best to organize people, information, money, and materials to produce and distribute services and products. Depending on the degree level, students are prepared to design, manage, perform research on, or teach about productive systems which may be in private industry, federal, state or local government, or in public, quasi-public, or non-profit institutions.

Engineering Management is concerned with the knowledge and processes required to manage technically based enterprises.

BACHELOR OF SCIENCE

The program leading to the degree of Bachelor of Science in Industrial Engineering is stated earlier under the School of Engineering. This curriculum is planned to serve those students whose long-run objective is the planning, designing, and implementing of complex

Stanford

economic and technological management systems where a scientific and engineering background is necessary or desirable. The fundamentals of engineering are stressed. The Industrial Engineering program is designed to introduce the student to measurement and control theory, organization theory and behavior, management, economic analysis and modeling, facilities planning and design, and utilization of computers and information systems. The objective is to provide the student with systems concepts, the role and function of management, methods of analysis, and the human and economic factors that bridge the gap between pure engineering design and pure management. To achieve the objective, the student will take several courses in which group projects comprise an important part of the course. In these projects, the student has the opportunity to formulate and solve problems and implement solutions for firms and organizations in the surrounding community.

Many students completing the bachelor's program will wish to pursue graduate study in Industrial Engineering, in other professional schools—law, medicine, or business—or in fields related to Industrial Engineering such as economics, statistics, or operations research.

ADVANCED DEGREES

The Department of Industrial Engineering and Engineering Management, in collaboration with other departments of the University, offers programs leading to the degrees of Masters of Science, Engineer, and Doctor of Philosophy in Industrial Engineering and to the degree of Master of Science—Engineering; Engineering Management.

Applicants for admission as graduate students in Industrial Engineering and Engineering Management must submit the results of the verbal, quantitative, and analytical aptitude parts of the Graduate Record Examination.

MASTER OF SCIENCE

The Master of Science degree programs require a minimum of 45 units beyond the equivalent of a Bachelor of Science degree at Stanford. All programs represent substantial progress in the major field beyond the equivalent of a bachelor's degree.

Any student admitted to graduate standing on the basis of a bachelor's degree in a field other than engineering must complete 45 units of work as outlined above, but must also have successfully completed or must complete the equivalent of 45 units of mathematics, science and engineering breadth. In addition, the stu-

the degree is available from the department of Industrial Engineering and Engineering Management. This program should be of particular interest to Honors Cooperative students.

ENGINEER

The Engineer degree is designed for students desiring the maximum academic preparation for a career of professional practice in the activities and areas described previously.

The Engineer degree requires two years of academic work beyond the bachelor's degree. Normally a program of study for the Engineer degree will include the courses required for the M.S. plus approximately 30 units of additional courses of a more advanced level and a thesis. Up to 15 units may be allowed for the thesis. The purpose of the thesis is to prove the professional competence of the candidate and not necessarily to make an original contribution to knowledge.

DOCTOR OF PHILOSOPHY

The Doctor of Philosophy in Industrial Engineering is for students who desire careers in teaching or in research, rather than in professional practice.

The degree of Doctor of Philosophy is offered under the general regulations of the University. The program requires a minimum of three years (nine quarters) of graduate study, at least one year of which must be at Stanford. The first year of study is usually represented by the M.S. program. The completion of an acceptable dissertation may occupy most of the candidate's third year of study.

The program of study will be arranged by the candidate with the advice of a Faculty Committee of three, appointed by the department head and having as chairman the faculty member who will direct the thesis work. The final program must be approved by the department.

ASSISTANTSHIPS AND SCHOLARSHIPS

A limited number of fellowships and assistantships up to \$10,000 per year are awarded each year. Application forms and detailed information may be obtained by writing the Department of Industrial Engineering and Engineering Management or the Graduate Admissions Office. Applications for assistantships and scholarships should be made by February 1 preceding the start of the academic year for which the award is to be made.

dent must be sure that he or she has complied with the prerequisites for the courses listed on the program for the M.S. degree.

INDUSTRIAL ENGINEERING

The Master of Science program is designed to provide sufficient additional skills over the B.S. course in Industrial Engineering to better prepare students for a professional career. It is also designed to prepare students with bachelor's degrees in other engineering disciplines to learn more about production and distribution systems. An additional use of the master's degree is as a step toward a second advanced degree.

Suggested or sample programs leading to the degree of Master of Science in Industrial Engineering are available. These sample programs and the requirements for the Master of Science degree may be obtained from the Department of Industrial Engineering and Engineering Management.

All Master of Science degree programs must contain certain core courses unless the student has already had equivalent courses before entering the Industrial Engineering graduate program. Only 20 units of these core courses may be applied toward the 45 units required for the M.S. degree.

ENGINEERING: ENGINEERING MANAGEMENT

The Master of Science degree in Engineering with a concentration in Engineering Management is designed to provide knowledge of the process of management as applied to technically-based enterprises and to provide additional skills in the student's basic engineering discipline. It is intended for students with the B.S. or M.S. degree in engineering disciplines other than Industrial Engineering (those with a B.S. degree in I.E. should pursue their M.S. in I.E.) It should be considered a terminal degree and not a step toward a second advanced degree. The Ph.D. is not offered in Engineering Management. Those students who expect eventually to pursue an M.B.A. degree should not apply. Students interested in management of construction or Civil Engineering Infrastructure should apply to the Civil Engineering department at Stanford.

The Degree of Master of Science in Engineering with a concentration in Engineering Management requires 30 units of specified courses in the Engineering Management area and a coherent package of 15 additional units of coursework typically in the student's technical area (beyond the previous degree level). A sample program outlining detailed requirements for

stressed. An understanding is developed of the usefulness and benefits of accounting data as well as of the limitations of that data. Students who have taken or are taking another University course in elementary accounting should not enroll. (DR:X)

4 units, Aut (Riggs) MWF 1:15 and one hour by arrangement
Spr (Staff) MWF 11 and one hour by arrangement

141. **Utilization of Computers**—Some background necessary for the effective use of computers in industrial engineering and management problems. Basic techniques used in data processing, information systems, and optimization are stressed. Topics covered include data representation, metaprograms, searching, sorting, list processing, network problems, and branch and bound. Prerequisites: Computer Science 103 and 106 or their equivalents. (DR:T)

3 units, Win (Jucker) MWF 1:15

144. **Simulation**—The design, creation, and analysis of simulations. The use of simulation for estimation, comparison of policies, and optimization. Emphasis is primarily on applications in the areas of production and management. Prerequisites: I.E. 121, I.E. 141, and O.R. 153. (DR:T)

3 units, Spr (Jucker) MWF 9

161. **Engineering Economy**—(Enroll in Engineering 161)

180. **Senior Project—Organizations**—Each student will participate in a major project as a member of a group of three or four students. Special attention will be given to problem identification and definition, and emphasis will be put on synthesizing feasible solutions to real problems. Restricted to IE majors in their senior year not enrolled in either IE 183 or IE 186. Not open to graduate students. Designed as a sequel to IE 100. (DR:X)

2 units, Win (Jucker, Eisenhardt) TTh 11-12:15

183. **Senior Project—Financial Analysis**—Each student will participate in a major project as a member of a group of three or four students. Special attention will be given to problem identification and definition, and emphasis will be put on synthesizing feasible solutions to real problems. Restricted to IE majors in their senior year not enrolled in either IE 180 or IE 186. Not open to graduate students. Designed as a sequel to IE 235. (DR:T)

2 units, Win (Hodder, Riggs)

ment—A survey of classical and modern organization theory, concepts and functions of management; and the behavior of the individual, the work group, and the organization. Enrollment limited with preference given to IE/EM majors. Graduate students are encouraged to take IE 203 instead. (DR:X)

4 units, Aut (Staff) TTh 10-11:50

Spr (Eisenhardt) TTh 10-11:50

107. **Work and Society**—(Same as Values, Technology and Society 170.) Historical and contemporary perspectives on work, particularly as conditioned by technology and transformed by technological change. Topics: Historical: studies of work in the pre-industrial world; the impact of the industrial revolution on work and community; philosophies of work and work-society relations; literary and sociological portraits of work life; and the work ethic in America. Contemporary: self-management and job-enrichment experiments, worker rights, corporate ethics, new technology and the transformation of work, regulatory, governmental, and union influences on work in corporations, and contrasting social and cultural approaches to work in the U.S., West Germany, Sweden, and Japan. (DR:A)

4 units, Win (McGinn) MW 2:15-3:05

two-hour seminar section by arrangement

121. **Statistics and Quality**—Basic statistics, including point and interval estimation, tests of hypotheses, and analysis of variance and elementary experimental design. Concepts and statistical methods employed in the assurance of product conformance to specifications in the industrial environment. Emphasis is placed on setting quality standards and using statistical methods and technology in design, design review, acceptance sampling, and process control. Prerequisite: Statistics 116. (DR:T)

4 units, Win (Staff) MWF 11

125. **Work Design and Measurement**—Concepts and techniques of designing, improving and measuring work performance and productivity of humans and of man-machine systems. Operations analysis, work design and human factors engineering, work and effort measurement and job evaluation. Small group project performed in local industry by all students. Prerequisite: IE 121. (DR:T)

4 units, Spr (Staff) MWF 10

133. **Industrial Accounting**—Introduction to basic accounting concepts and operating characteristics of accounting systems. Principles of financial and cost accounting, design of accounting systems, techniques of analysis and cost control. Course is designed for the user of accounting information and not as a first course for those preparing for careers as professional accountants. Interpretation and use of ac-

UNDERGRADUATE COURSES

100. **Organizations**—Theories and Man-

signed to be an action-oriented curriculum concerned with functional airline management in five basic fields: Marketing, Finance, Administration, Operations, and Planning. Airline management problems and techniques will be studied both academically and on airline field trips. There will be extensive use of case studies and project studies with airline executives. (DR:X)

4 units, *Spr (Banfe) MF 3:15-5:05*

234. Research and Development Management—The function of research and development in the business enterprise. The practical problems of project selection, integration of R&D with marketing, production, and financial management; selection and retention of scientists and engineers; establishment of research priorities; financial controls of R&D operations; R&D evaluation. An examination of the current state of the art in technological forecasting. Prerequisite: graduate standing or consent of instructor. (DR:X)

3 units, *Win (Blake) M 2:15-5:05*

235. Introduction to Financial Decisions—(Same as Economics 112.) This course focuses on the models and techniques in financial decision-making under uncertainty. Topics covered include risk measurement, expected utility theory, decision trees, and portfolio and capital market theories. The effects of taxation and inflation are also discussed. Prerequisites: Engr 161, OR 152, IE 133 and Stat 116 (DR:T)

3 units, *Aut (Staff) MWF 9*
Win (Hodder) MWF 10

237. The Firm in the International Economy—(Same as Economics 167.) The response of firms to international economic forces. Exposure to exchange rate movements, trade barriers, and international taxation. Implications for accounting, financial and production practices. Prerequisites: I.E. 235 (required) and Econ 165 (recommended). Enrollment limited at discretion of instructor (preference given to students with recommended prerequisite). (DR:X)

3 units, *Spr (Hodder) MWF 10*

241. Evaluation of Industrial Projects—This course focuses on the evaluation of industrial investment projects under uncertainty. The effect of resource rationing is also considered. Available techniques for addressing these problems are examined with regard to both their theoretical properties and practical applicability. Although the course is applications oriented, it assumes a solid background in financial theory and quantitative methods. Prerequisites: IE 235 and IE 144 or equivalents. (DR:T)

3 units, *Spr (Staff) TTh 11-12:15*

186. Senior Project—Production—Each student will participate in a major project as a member of a group of three or four students. Special attention will be given to problem identification and definition. Students will be expected to apply analytic methodology obtained from previous course work, when appropriate; but the emphasis will be on synthesizing feasible solutions to real problems. Restricted to IE majors in their senior year not enrolled in either IE 180 or IE 183. Not open to graduate students. This course is designed as a sequel to IE 260. Prerequisite: I.E. 260. (DR:T)

2 units, *Win (Carlson, Hausman) TTh 11-12:15*

191. Directed Study—Directed study on subject of mutual interest to student and staff member. Student must find a sponsor and submit a one-page description of plan. (DR:X)

1 or more units, (Staff) by arrangement

COURSES PRIMARILY FOR GRADUATE STUDENTS

201. Problem Solving—(Same as Engineering 190.) An investigation of problem solving with particular emphasis on problem definition, creativity, and interpersonal and organizational factors that influence thinking. Common blocks to problem solving will be explored and methods of dealing with them will be presented. The advantages of integrating various problem solving strategies will be stressed through use of reading, abstracted problem situations, and projects. Open to undergraduates and graduates in any field.

3 units, *Spr (Adams) TTh 10-12*

203. Organizational Behavior and Management—A study of organization theory; concepts and functions of management; behavior of the individual, the work group; and the organization. Substantial emphasis on case and related discussion. Enrollment limited and restricted to graduate students. (DR:X)

3 units, *Aut (Tucker) 11-12:50*

208. Man-Machine Systems—Design and analysis of human and man-machine systems with emphasis on man-machine interface design. Physiological considerations such as size, effort and skill; informational considerations, such as vision, audition, and tactile sensing; and intellectual considerations, such as subjective decision making. Special topics include interactive information systems, keyboard design, public information display (for passengers, patients, etc.) and the man-robot interface. (DR:T)

3 units, not given 1951-52

216. Airline Management—This course is de-

242. Financial & Organizational Control—A survey of design strategies for rewards, structures, and performance evaluation systems in organizations. Approaches from economics/ accounting, and the behavioral sciences are used. Prerequisites: IE 100 or IE 203 and IE 133. Enrollment limited to majors. (DR:T)

3 units, *Spr (Eisenhardt) TTh 1:15-3*

260. Analysis of Production Systems I—Introduction to the design, scheduling, and control of production systems using mathematical, computational, and other modern analytical techniques. Areas investigated will include capabilities and costs of production systems, determination of optimal facility location, determination of production lot sizes, and optimal timing and sizing of production capacity expansion. Prerequisites: OR 152, Engr 161, Stat 116 (required), and IE 121 (recommended). (DR:T)

3 units, *Aut (Carlson) TTh 9:30-10:45*
Win (Carlson) TTh 9:30-10:45

261. Analysis of Production Systems II—Scheduling and control of production—inventory systems. Demand forecasting, inventory control, production scheduling, aggregate production and work force planning, materials requirements planning and integrated systems. Prerequisites: I.E. 260 and O.R. 153. (DR:T)

3 units, *Win (Hausman) TTh 1:15-2:30*
Spr (Hausman) TTh 1:15-2:30

262. Analysis of Production Systems III—Design and operation of production—inventory systems. Production scheduling, capacity planning, plant location, sequencing, assembly line balancing, multigoal optimization. The reading material will be drawn primarily from journal articles. Prerequisite: I.E. 260. (DR:T)

3 units, *Spr (Carlson) TTh 9:30-10:45*

269. Industrial Marketing—The various elements of the marketing plan are investigated as they relate to the marketing of industrial (as contrasted with consumer) products and services. The importance of identifying market needs and relating them to product development is stressed. Other elements such as pricing, channels of distribution, sales organization, promotion, communication and response to competitive actions are examined, largely through the discussion of cases. Throughout the course, the interaction of the marketing plan and overall corporate strategy is stressed. Enrollment restricted to graduate students. (DR:X)

3 units, *Aut (Staff) TTh 8-9:15*

270. Managing Technical Companies—This course focuses on the role of general management in technical companies, integrating marketing, finance, operations, control and organization. The course provides experience in

"matching" market needs and technical product developments. Cases are used extensively to provide real life opportunities for analysis, planning and decision making. The course provides the necessary background for I.E. 271 which focuses on the start-up of a new business venture. Open to graduate engineers only. Prerequisites: I.E. 133 (or equivalent) I.E. 269 and IE 100 or IE 203. Enrollment limited and at discretion of instructor. (DR:T)

4 units, *Win (Riggs) MWF 8 plus one hour by arrangement*

271. New Enterprise Management—(Same as Graduate School of Business 353.) Following on the course in Managing Technical Companies, this course is offered for students interested in starting a new business and/or participating in the management of a small, ongoing business during its formative stages. Emphasis is on the development and evaluation of realistic, action-oriented business plans to launch new enterprises. Legal, financial and related considerations that are peculiar to new ventures are also discussed. Students, working alone or in small groups, are required to develop a detailed business plan for a specific, proposed new venture. Prerequisite: I.E. 270. Enrollment limited and at discretion of instructor. (DR:T)

4 units, *Spr (Staff) MF 8-9:50*

291. Industrial Engineering Problems—Directed study on subject of mutual interest to student and staff member. Student must find a faculty sponsor. (DR:X)

1 or more units, (Staff) by arrangement

300. Thesis—Work on thesis for degree of Engineer. (DR:X)

Aut, Win, Spr (Staff) by arrangement

301. Dissertation—Work on dissertation for degree of Doctor of Philosophy. (DR:X)

Aut, Win, Spr (Staff) by arrangement

310. Colloquium in Industrial Engineering—Departmental colloquium on current research and applications in industrial engineering. There will be approximately four presentations each quarter by visitors, faculty, and students. Graduate students may register for one unit (total) for three quarters. No letter grades will be given. Ph.D. students must attend during every quarter in residence. (DR:X)

1 unit, *Aut, Win, Spr (Staff) T 4:15-5:30*

330. Doctoral Research Seminar in Financial Economics and Control—Topics from current published literature and working papers. Content varies with faculty and student research interests. Open to doctoral students with re-

168 SCHOOL OF ENGINEERING

search interest in the application of financial, accounting, and economic theory to industrial engineering problems.

3 units, *Spr (Staff) MW 3:15-4:30*

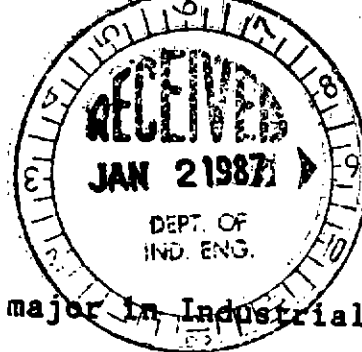
360. Doctoral Research Seminar in Production—Topics from current published literature and working papers. Content will vary from year to year. Open to doctoral students interested in research problems and issues in the production-inventory area. Prerequisite: I. E. 260 and at least one of I. E. 261, 262 or equivalent. (DR:T)

3 units, *Aut (Hausman) MW 1:15-2:30*

380. Doctoral Research Seminar in Organizations—Topics from current published literature and working papers. Content varies from year to year with faculty and student research interest. Open to doctoral students interested in research problems and issues in the fields of organizational design, behavior and control.

3 units, *With (Staff) not given 1981-82*

CLEMSON



GRADUATE PROGRAMS

Both the M.S. and Ph.D. degrees with a major in Industrial Engineering are offered.

An important feature of the graduate industrial engineering program is the flexibility to tailor plans of study to individual student interests and needs. Students may concentrate their studies in selected industrial engineering topics and choose minor areas of study from a wide range of fields. Students may also concentrate their studies in a particular problem area such as facilities planning and material handling, quality control and reliability, decision support systems, computer-based control, information/communication systems, artificial intelligence, human factors, engineering economics, maintenance systems, or the design, analysis, and simulation of manufacturing systems.

I.E. Graduate students are encouraged to engage in field studies, often in nearby industries. Field projects are arranged through graduate courses, departmental research, and graduate fellowship/internship programs. These activities often lead to excellent thesis or dissertation subjects. For more information, refer to the section in this booklet entitled "PARATEC PROGRAM" (page 11) and check with the PARATEC Program Coordinator, Professor C. R. Lindenmeyer.

If the student chooses, he or she may devise a plan of study that combines industrial engineering core courses with courses from other departments in the College of Engineering and the University. The primary purpose of such a plan is to permit optimum use of the total University resources to provide the best possible preparation for a professional career in industrial engineering.

Students with a bachelor's degree in engineering or physical sciences may be accepted. Those with other backgrounds may be accepted or may be required to successfully complete certain prerequisite courses before formal entrance into the program. For information on specific prerequisite course requirements, call the graduate student coordinator at 656-4716.

CATALOG INFORMATION

(Page number references are from the Clemson University Graduate School Announcements, 1986-1987.)

Admission Procedures and Requirements ... pp.	31 - 37
Expenses, Tuition and Fees	pp. 23 - 27
Student Services	pp. 19 - 23
Financial Aid	pp. 27 - 31
General Graduate School Regulations	pp. 39 - 46
Degree Requirements	pp. 49 - 55
I.E. Degrees and Description of I.E. Courses	pp. 190 - 193

GRADUATE PROGRAM GUIDELINES

Entering graduate students are assumed to have had the following courses as part of their formal academic background:

1. One course in digital computer programming,
2. One course in probability theory and one in mathematical statistics,
3. One course in engineering economic analysis,
4. Three courses in college-level calculus, and
5. Two courses in college-level physics.

A student without these prerequisites will be required to satisfy them as part of his/her graduate program.

The graduate program for each student is developed around the following core courses:

IE 666 - Production Systems Engineering	(3 credits)
IE 680 - Methods of O.R. I	(3 credits)
IE 681 - Methods of O.R. II	(3 credits)
IE 682 - Systems Modeling	(3 credits)
IE 686 - Production Planning and Control	(3 credits)

The requirement for any of the above courses may be waived if the student has successfully completed an equivalent course at this or another institution. The decision on this waiver is made by the student's advisory committee with the approval of the department head. In addition, all graduate students are required to complete a sequence of three graduate seminars, IE 895, for one credit each.

The remainder of the student's program of study is designed uniquely for each student in collaboration with, and subject to the approval of, the student's advisory committee. Page 18 of this booklet contains a listing of graduate courses offered by the department. See The Graduate School Announcements 1986-87 (pp. 190-193) for a description of these courses. Page 28 of this booklet presents a summary of the "expected" scheduling, by semester, of departmental courses to be offered in the next two years.

INDUSTRIAL ENGINEERING GRADUATE COURSES

OPERATIONS RESEARCH/SYSTEMS ENGINEERING

IE 652 - Reliability Engineering	3 cr.	(3,0)
IE 680 - Methods of O.R. I	3 cr.	(3,0)
IE 681 - Methods of O.R. II	3 cr.	(3,0)
IE 703 - Engineering Project Operations ...	3 cr.	(3,0)
IE 803 - Engr. Optimization and Applic. ...	3 cr.	(3,0)
IE 860 - Dynamic Programming	3 cr.	(3,0)
IE 861 - Nonlinear Programming and Methods of Search	3 cr.	(3,0)
IE 880 - Advanced Methods of O.R.	3 cr.	(3,0)
IE 888 - Applied Queueing Theory and Markov Processes	3 cr.	(3,0)

PRODUCTION (MANUFACTURING) SYSTEMS: PLANNING, DESIGN, AND CONTROL

IE 666 - Production Systems Engineering ...	3 cr.	(2,3)
IE 673 - Microcomputer Applic. in I.E.	3 cr.	(2,3)
IE 685 - Industrial Systems Engineering ...	3 cr.	(3,0)
IE 686 - Production Planning and Control ..	3 cr.	(3,0)
IE 865 - Facility Planning and Material Handling	3 cr.	(3,0)
IE 873 - Computer-Aided Manufacturing	3 cr.	(2,3)
IE 886 - O.R. in Production Control	3 cr.	(3,0)

DIGITAL SIMULATION: MODELING, ANALYSIS AND APPLICATIONS

IE 682 - Systems Modeling	3 cr.	(3,0)
IE 807 - Discrete Systems Simulation	3 cr.	(3,0)
IE 808 - Continuous Systems Simulation	3 cr.	(3,0)
IE 885 - Design and Analysis of Simulation Models	3 cr.	(3,0)
IE 907 - Production Systems Simulation	3 cr.	(3,0)

ENGINEERING ECONOMICS

IE 684 - Engineering Economic Analysis	3 cr.	(3,0)
IE 884 - Advanced Engineering Economic Analysis	3 cr.	(3,0)

HUMAN FACTORS ENGINEERING

IE 688 - Human Factors Engineering	3 cr.	(2,3)
--	-------	-------

FACULTY LISTING

JAMES A. CHISMAN, Ph.D. (Iowa University), P.E., Professor of Industrial Engineering. Production planning and control, systems modeling/simulation, applied optimization.

STEPHEN C. CLARK, B.S.E.E., (Duke University), P.E., Instructor of Industrial Engineering. Manufacturing processes, numerical control machining and manufacturing engineering.

ROBERT P. DAVIS, Ph.D. (Oklahoma State University), P.E., Professor and Head of Industrial Engineering. Applied optimization, optimal and adaptive control, planning, design and control of manufacturing systems.

JOEL S. GREENSTEIN, Ph.D. (University of Illinois), Associate Professor of Industrial Engineering. Human factors engineering, applied probability and statistics, human-computer interaction and computational methods in industrial engineering.

WILLIAM J. KENNEDY, Jr., Ph.D. (Virginia Tech), P.E., Professor of Industrial Engineering. Energy management, production planning and control, quality control and reliability, maintenance systems.

CARL R. LINDENMEYER, M.S. (Western Michigan University), Professor of Industrial Engineering. Computer-assisted work measurement, industrial ergonomics, statistical quality control, facilities planning and design, micro-computers for industrial engineering application.

BEVLEE A. WATFORD, Ph.D. (Virginia Tech), Assistant Professor of Industrial Engineering. Facilities planning and material handling, applied digital simulation, manufacturing systems engineering, engineering economics.

MEMORANDUM

TO: Dr. Sidney L. Besvinick
Associate Provost and Dean for Research
and Graduate Studies, Interim

FROM: Dr. John Knoblock
Chairman, Faculty Senate

DATE: November 21, 1986

SUBJECT: Proposed Ph.D. Degree Program in Industrial
Engineering

Please have the Graduate Council supply to the Senate Council the additional material required by the new guidelines for graduate programs.

JK/b

cc: Dean Norman Einspruch
Dr. Tarek Khalil


College of Engineering's Proposal for a Ph.D. in Industrial Engineering

Dr. Knoblock appointed Dr. Jack Fell as the chairman of a committee to review the proposal for a Ph.D. in Industrial Engineering.

Matters from the Floor

The Chairman read a letter from the President thanking the Senate for the reception held for Mr. McLamore and him. He also mentioned that the Chairman of the Board of Trustees was deeply appreciative of the Senate's gesture.

The meeting adjourned at 5:30 P.M.


Barbara L. Hoadley
Secretary to the Faculty Senate



M E M O R A N D U M

October 13, 1986

TO: Dr. John Knoblock, Chairman
Faculty Senate

FROM: Associate Provost for Research
and Dean of Graduate Studies (Interim)

SUBJECT: Proposed Ph.D. in Industrial Engineering

On October 8, 1986 the Graduate Council approved the offering of the Doctor of Philosophy in Industrial Engineering as described in the enclosed material. Note that the Council gave its approval subject to the implementation of four actions over the next few years, including the employment of an additional faculty member, additional teaching assistants and similar provisions.

The Graduate Council also took another action that affects this recommendation. Henceforth, all degree programs approved for implementation will be subjected to a formal review during the third year following their approval to determine if the required provisions have been met. The policy is effective with this proposed new degree.

Please let me know if the Senate requires any additional information from the Graduate Council.

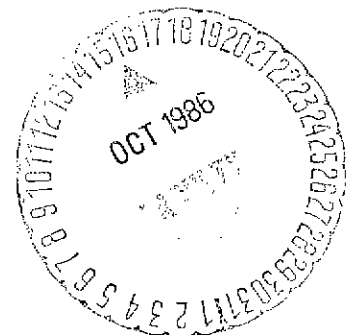
A handwritten signature in black ink, appearing to read "Sidney L. Besvinick". The signature is fluid and cursive, with a large loop at the end.

Sidney L. Besvinick

SLB:nb

cc: Dr. Tarek Khalil, Chairman
Department of Industrial Engineering
Dr. Norman G. Einspruch, Dean
College of Engineering
Dr. Luis Glaser, Provost

Graduate School
P.O. Box 248125
Coral Gables, Florida 33124
(305) 284-4154



IEnFIN.TRU

MEMORANDUM
July 24, 1986

To: Dean of the Graduate School and the Graduate Council

From: Physical Sciences Sub-Committee
 Arthur Bassett, Christopher Harrison, Jo Anne Hecker, Co-Ch., Tarek Khalil, James Nearing, Carroll Truss, Co-Ch., Norman Weinberg

Subj: Response to outside reviewers and final recommendations regarding proposed Ph.D. in Industrial Engineering.

Encls: (1) Summary of recommendations, departmental response, and committee response.
 (2) October 17, 1985, Memoranda to Chairman, IEn and to Provost showing Graduate Council actions of October 9th and Sub-Committee Report and Recommendations to the Council.
 (3) Memorandum showing financial support for IEn from Dr. Rosomoff, Chairman, Department of Neurological Surgery.

The Committee met several times to review the report of the outside reviewers (Don B. Chaffin, The University of Michigan and Frank Tillman, Kansas State University) for the proposed Ph.D. in Industrial Engineering, who visited the campus April 10-11, 1986.

The reviewers provided an eight page review, first stating key criteria, then dealing in detail with each of the proposed concentrations. Their report has been reviewed by the Department of Industrial Engineering and by this committee. Enclosure 1 is a summary of the reviewers' recommendations, of the Department's responses, and of this Committee's responses.

The reviewers state, "In summary, the ergonomics research program applied to rehabilitation and occupational health planning is well developed and could support a few Ph. D. students with small incremental costs (some faculty released time, supplies, TA appointments, etc.)."

Regarding the proposed production systems engineering program they say, "The emphasis of this program not being in the traditional manufacturing field is a good direction to take since the laboratory equipment and space required are not available." They recommend an additional senior faculty member in this area, and alleviation of heavy teaching loads through the added person and some TAs. They add, "Because of its emphasis, this program appears to be able to flourish if the research is focused on computer based topics and utilizes industrial sites to conduct experiments."

Regarding cost, they say, "Present external funding for ergonomics is barely adequate to support 3 to 4 Ph. D. students each year." They say of production management, "It appears it will

take at least \$100,000/yr minimum to establish this program and to hire the faculty and GTA's needed. Also the tuition waivers for graduate students represent a cost that must be considered." Also, "A goal for (outside funded research) funding should be at least \$250,000."

They conclude, "The Department has identified two areas that they can excel in, Ergonomics and Production Systems Engineering. We believe with this focus, the available resources and the above mentioned concerns and support requirements that a viable Ph. D. program in Industrial Engineering can be established at the University of Miami."

The committee agrees with this last statement and again supports inauguration of this program subject to the following stipulations, essentially the same three recommended in its original report:

1. Addition of a Professor or a senior Associate Professor in Production Systems Engineering with good research experience by Fall, 1987.
2. Authorization of additional Graduate Teaching Assistantships on the schedule recommended in our original report dated Oct. 17, 1985 (Summary of Data, page 3, and in the recommendations section). Specifically, add two TAs in September, 1987, one in September, 1988, and one in September, 1989.
3. Limitation of post-masters Ph.D. level students to five per year in each of the first two years, with no further admissions unless there has been timely addition of TAs, of the new faculty member, and of budget amounts, adjusted for inflation, as indicated in the Summary of Data referenced above.
4. By this memorandum, the committee calls to the attention of the Dean of the Graduate School the resolution adopted by the Graduate Council on October 9, 1985 (See Page 2 of Encl. 1), which directs the Dean to seek assurances from appropriate authorities that stipulated support will be forthcoming, and to report on this to the Graduate Council.

The Committee

SUMMARY OF REVIEWER'S RECOMMENDATIONS, DEPARTMENTAL RESPONSE, AND SUB-COMMITTEE'S RESPONSE FOR IEN PH.D. PROPOSAL

Standards rec. by reviewers:	U-M re Standards per reviewers	Dept. Response	Sub-Com. response
Methodology educ. requires 3rd level courses, etc. Should have supervisory com. for acad. & res. for students.	ERGONOMICS-OK PROD. s .needs senior person OK	Agree Agree, are doing now	Agree Agree, OK
Need exper. graduate faculty that routinely publishes research.	ERGONOMICS-OK PR.S.-Need Senior person	Agree	Agree
Need external fund-support Ph.D. Program.	ERGONOMICS-OK for 3-4 Ph.D. students/yr Need \$50,000/yr per student. PROD.S.-Max of 5. Need \$50,000/S.	Funding need \$25-30,000/yr. per student, either program.	Agree with Dept.
Released time for research & to work with students. Two course limit.	Two course limit necessary for all Fac. active with students & in research.	Agree.	Agree
Clear focus(s) to Ph.D. Program(s) needed. Feel proposal demonstrates.	OK-Proposal has two clear areas. Should emphasize research & publication.	Agree	Agree
Adequate space & equipment needed.	ERGONOMICS-can support 5 students if technician(1/2), TA support, supplies, travel are adequate. is PROD.SYS MGT ok if it emphasizes *EDP & does experiments at industrial sites.	Agree. Note that new space is coming with eng'g addition. Much equipment being donated. In long term will need \$50-100,000 for misc. equipment to make proper use of gifts. Will need to add 1/2 tech. in 2 yrs.	Agree

*EDP = Electronic Data Processing

Incremental Fund-
required.

Apprx \$100,000/yr.
for faculty & Ph.
D. students plus
outside funding of
about \$250,000.

Agree. Grants=
\$247,000+ with
3 prop. for \$100,
000 pending (+
Dr. Wiener's \$110,
000 grant helps
some)

Agree. Offset
partly by paid
tuition by
companies &
indiv. studs.
Most tuition
must be from
U-M.

New faculty
required

One senior person
in Prod. Systems.

Agree.

Agree. Re-
viewers re-
commend per-
son in Prod.
Sys.; We had
rec. in Erg.
but now agree
with review-
ers.



M E M O R A N D U M

October 17, 1985

TO: Dr. Tarek Khalil, Chairman
Industrial Engineering

FROM: Associate Provost and Dean for Research and
Graduate Studies (Interim)

SUBJECT: Proposed Program for Ph.D. in Industrial
Engineering

At the Graduate Council meeting of October 9, 1985, Council voted to recommend approval of the proposed Ph.D. in Industrial Engineering, subject to the following stipulations:

a. Addition of a graduate faculty qualified Associate Professor with experience in a graduate program elsewhere who has strong qualifications in the Ergonomics/Human Factors area. We recommend that this person be in place at the beginning of the second year of the program instead of the fourth year as proposed by the Department.

b. Addition of two Graduate Teaching Assistants in the first year, one in the second year, and one in the third year of the program who, with the additional faculty member will free time for the faculty needed as the number of doctoral students increases.

c. That the number of doctoral level admissions (past the M.S.) be limited to five students in each of the first two years. Further admissions thereafter, beyond a total of 10 FTE doctoral students, is not to be allowed unless there has been timely addition of TAs, of the new Associate Professor, and of budget amounts (adjusted for inflation) as indicated in the Summary of Data.

Dr. Jo Anne Becker will arrange for two external evaluators to visit campus in the near future to review the proposed program. You may wish to nominate 2 or 3 prominent Industrial Engineering faculty members. If so, please forward their names, addresses and phone numbers to her.

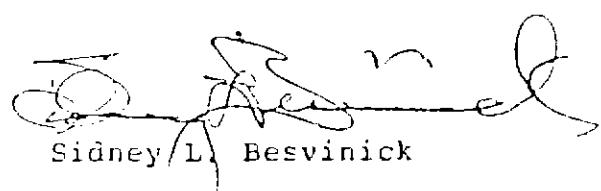
Graduate School
PO Box 248125
Coral Gables, Florida 33124
(305) 284-4154

Dr. Tarek Khalil
October 17, 1985
Page 2

For your information, Council also approved the following resolution and asked that I forward it to the Provost.

The Graduate Council is very much concerned that financial and other support for new graduate programs, as stipulated by this Council at the time of their approval, have not been provided. We cite specifically the Ph.D. in Biomedical Engineering, the M.A. in Communication, and the Ph.D. in Economics, all approved since 1981.

We hereby request and direct the Dean of the Graduate School to pursue with the Provost, and with the President if need be, this problem of financial support, to seek assurances that stipulated support will be forthcoming, and to report progress to this Council. We note that oversight of the academic adequacy of graduate programs is a function of the Council, and that enrollment in underfunded graduate programs often should be limited.



Sidney L. Besvinick

SLB:nb
cc: Dean Norman G. Einspruch



MEMORANDUM

October 17, 1985

TO: Dr. William F. Lee III
Executive Vice President and Provost

FROM: Associate Provost and Dean for Research and
Graduate Studies (Interim)

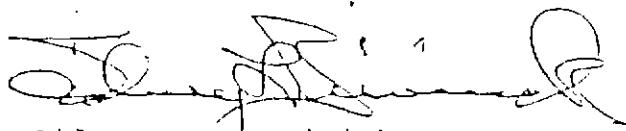
SUBJECT: Resolution of the Graduate Council Regarding New
Graduate Programs

At the Graduate Council meeting of October 9, 1985, Council unanimously approved the below Resolution:

The Graduate Council is very much concerned that financial and other support for new graduate programs, as stipulated by this Council at the time of their approval, have not been provided. We cite specifically the Ph.D. in Biomedical Engineering, the M.A. in Communication, and the Ph.D. in Economics, all approved since 1981.

We hereby request and direct the Dean of the Graduate School to pursue with the Provost, and with the President if need be, this problem of financial support, to seek assurances that stipulated support will be forthcoming, and to report progress to this Council. We note that oversight of the academic adequacy of graduate programs is a function of the Council, and that enrollment in underfunded graduate programs often should be limited.

I would like to meet with you in the near future to discuss the ramifications of the implementation of this resolution.



Sidney L. Besvinick

SLB:nb

cc: Dean Jack R. Borsting
 Dean Norman G. Einspruch, Graduate School
 Dean David Gordon, PO. Box 248125
 Coral Gables, Florida 33124
 (305) 264-9154

October 9, 1985

8

To: The Graduate Council and Dean of the Graduate School
From: Committee on Programs and Degrees of the Graduate Council
Subj: Report and Recommendations Regarding the Proposed Ph.D.
in Industrial Engineering

1. The Committee met eight times last Spring and early this Fall to study this proposal, with the Department Chairman present at most meetings.

2. We find that space, equipment and library are adequate. More sophisticated equipment is needed. Apparently there is good prospect of acquiring the approximately \$250,000 in equipment via gifts and grants over the next five years. We support the Department's request for a modest U-M contribution each year for accessories and maintenance. Library holdings are good, subject to one-time backfilling and about \$2,000 per year in new journal subscriptions, two-thirds of which are already in place, so that only about \$664 per year additional will be needed. Small increments for office supplies and in travel money for faculty are recommended. Staff and technician needs are minor and are not required immediately.

3. The faculty is small (eight) with only three members on the Graduate Faculty, and five who are relatively new Assistant Professors with little publication yet, including one who will arrive in January. However, two former members of the Department, Professor Earl Wiener who is now in Management Science, and Professor Joseph Moder, former Department Chair, also in MAS, are on the Graduate Faculty and have extensive experience in graduate work. Other Secondary Appointees, who include Professor Charles Kurucz, also on the Graduate Faculty, and several faculty members in the School of Medicine, are working in the proposed areas of concentration, and will contribute experienced research guidance. We recommend one new line at the Associate Professor level to be in place by the second year of the program, and to be qualified upon arrival for Graduate Faculty status. Preferably he or she should have experience in graduate research supervision elsewhere.

The Committee recommends the faculty as marginally adequate, assuming that in the current year several of the junior faculty will be published with articles already submitted.

4. Extramural support includes several hundred thousand dollars annually from the State of Florida to support student tuition supplements. Research grants in 1984-85 exceeded \$107,000. New grants include one from IBM for \$220,000, and over \$37,000 in the form of four small grants. Several proposals are pending.

The Committee recommends extra-mural research support as adequate and likely to grow.

5. In summary, The Committee recommends approval of the proposed Ph. D. in Industrial Engineering, subject to the following stipulations:

a. Addition of a Graduate faculty qualified Associate Professor with experience in a graduate program elsewhere who has strong qualifications in the Ergonomics/Human Factors area. We recommend that this person be in place at the beginning of the second year of the program instead of the fourth year as proposed by the Department.

b. Addition of two Graduate Teaching Assistants in the first year, one in the second year, and one in the third year of the program who, with the additional faculty member will free time for the faculty needed as the number of doctoral students increases.

c. That the number of doctoral level admissions (past the M.S.) be limited to five students in each of the first two years. Further admissions thereafter, beyond a total of 10 FTE doctoral students, is not to be allowed unless there has been timely addition of TAs, of the new Associate Professor, and of budget amounts (adjusted for inflation) as indicated in the Summary of Data.

d. Early inauguration of this program is strongly recommended in view of state support priorities and considerations, and because we recognize the IEn faculty as likely to develop rapidly. However, we call the attention of the Graduate Council to the apparent problems in funding adequately the Biomedical Engineering-Ph. D. program, in that the Council's stipulation that a senior full professor must be brought in very soon after the program was approved in 1981, has not been met.

It may be that the School of Engineering is not able to support both programs to levels this Council deems necessary for them to be adequate academically. We recommend that the Council request assurances from the Dean of the School of Engineering as to which he will support or if he is prepared to support both. Thus, although we urge continuing the approval process for IEn, we recommend that the question of whether the program can and will be supported financially be resolved before students are accepted.

We recommend to the Council, also, the enclosed resolution addressed to the Dean of the Graduate School. It expresses our concern that stipulations accompanying recommendations for approval of the Ph. D. in Biomedical Engineering, the M.A. in Communication, and the Ph. D. in Economics have not been met. The Dean is asked to communicate this concern to the Provost and to the President, and to report back to the Council.

The Committee on Programs and Degrees:

Arthur L. Bassett (New, Fall, 1985)
Christopher G. A. Harrison
Tarek M. Khalil
Pamela A. Ferguson (Term ended, May, 1985)
James C. Nearing
Norman L. Weinberg
Carroll V. Truss, Co-Chair
Jo Anne K. Hecker, Co-Chair

The Graduate Council is very much concerned that financial and other support for new graduate programs, as stipulated by this Council at the time of their approval, have not been provided. We cite specifically the Ph. D. in Biomedical Engineering, the M. A. in Communication, and the Ph. D. in Economics, all approved since 1981.

We hereby request and direct the Dean of the Graduate School to pursue with the Provost, and with the President if need be, this problem of financial support, to seek assurances that stipulated support will be forthcoming, and to report progress to this Council. We note that oversight of the academic adequacy of graduate programs is a function of the Council, and that enrollment in underfunded graduate programs often should be limited.

Current Programs:

UG - 180 Students. Credit Hours, F, 1984-	1,935	
M. S. Students - 35. " "	190	(21 FTE)
Total CH taught	<u>2,125</u>	

Faculty:

Full time - 8 (All Ph.D.)	On Graduate Faculty
Secondary Appointments - 5 (All Ph. D.)	<u>3</u>
	<u>4</u>

Present Teaching Load, FT Faculty - 2.5 courses, 7.5 Mean C.Hrs.

Theses produced - 4 M. S.'s awarded - 26, last 6 yrs.
11, 1984-85 only

Adaniya, Oscar Ph. D. Georgia Tech., 1983, JEn Assistant Prof.
Ref. Art. & Ch. - None /M.S. Ohio State, 1977 Came Fall, '82.

Books & Monographs - None

Misc. - 1980, 82.

Thesis & Dissert. Com. - "Supervised M.S. Projects" Otherwise, none.

Grants - None. (Proposal goes to DOT in June, one to NSF in Dec., 1985)

GF Asfour, Shihab S. Ph. D. Texas Tech, 1980; M.S. Alexandria Univ., 1976.
Associate Professor.

Art. & Ch. - 60, 80, 80, 80, 82, 83, 83, 83, 84, 84, 84, 1 in press.

Books & Mono. - None.

Misc. - 77, 78, 78, 78, 79, 80, 81, 81, 82, 82, 83, 83, 84, 84, 84, 84, 84, 84.

Thesis & Dissert. Comm. - 4 Chair - 1 In Prog. M, 2; Ch. or Co-C, 3.

Grants - 1981 (in-house Biomed NIH), \$3996; 1982, Amer. Can., \$3625
1982, Dept. of Neurosurgery, Co-PI, \$210,000 (to present)

Rabie, A. M. Ph. D. University of Nottingham (England), 1982. MSc Univ. of
Manchester, 1975. Assist. Professor.

Art. & Ch. - 1 submitted

Books & Mono. - None.

Misc. - 83 84 85 (All Conference Proceedings)

Kang, Keebom Ph. D. Purdue, 1984; M.S. 1979, Texas. Assistant Prof.
Art. & Ch. - 2 Submitted. Came, Fall, 1983.

Books & Mono. - None

Misc. - None.

Thesis & Dissert. Comm. - M, 1.

Grants - None, but submitted two in-house last year that were not funded.

GF Khalil, Tarek M. Ph. D., Texas Tech, 1969; M.S.I.E., 1968
Texas Tech. Professor and Chair.

Art. & Ch. - 33 and 6 in press.

Books & Mono. - None.

Misc. - 64.

Thesis & Dissert. Comm. - M - 9 Chair - 7 (includes some at U. Fla.)

Grants - PI or Co-PI on 6 grants, last in 1980. + 1, 1982 to present (PI).

Omachonu, V. K. Ph. D. (expected) Spring, 1986 M. S. Oper. Res. Columbia Univ. 1983.
M.S. Un. of Miami, Ind. Engg., 1980. Arrives Jan., 1986.

Art. & Ch. - None.

Books & Mono. - None.

Misc. - None.

Grants - None.

MSE Michigan, 1976. Assistant Professor. (Came Fall '83)

Art. & Ch. - (3 submitted)

Books & Mono. - None.

Misc. - 1977, 1974.

Thesis & Dissert. - Member - 1 Ch. 3 (All at Univ. Metro., Caracas)

Grants - None.

GF Sumanth, David J. Ph. D. Ill. Inst. of Tech., 1979; M.S. 1974,
Ill. Inst. of Tech.; M. S. 1967, Osmania Univ. Assoc. Prof.
Art. & Ch. - 83, 84. Tenure due.
Books & Mono. - 1981, 81, 81, 81 (all manuals), 1984, text. bk in press.
Misc. - 17.
Thesis & Dissert. Comm. - M - 1 Chair - 3.
Grants - 80-82, \$40,000, PI, NSF. Neg. as Co-PI \$150,000 with IBM.
Secondary Appointments - Goldberg, M. L. (Psychologist); Kurucz, C. N.
(Management Science), GF; Moder, J.J. (Oper. Res., etc.) GF;
Pfaffenberger, C. D. (Organic Chemistry, Med. Sch.) GF;
Wiener, E. L. (Mgmt Sci.) GF;

Extramural Funding:

By year. 1978: \$102,000; 1979: \$408,700; 1980: \$93,000; 1981: \$60,700;
1982: \$289,000; 1983: \$455,000 (incl. \$97,000 State Tuition Subsidies);
1984-85: \$107,700 in hand, plus \$99,000 state tuition subsidy, and
\$311,000 under negotiation and likely; 1985-86: State tuition
subsidy of \$265,000 expected. 13 separate grantors are currently
involved. (Recent- Adaniya, \$7,750; Rodriguez, \$7,500 (U-M); Khalil, \$6,000.)
Wiener, Sizable NASA grant; Sumanth, telephone confirmation,

Library:

Holdings listed include 100 in one list and 115 in a second
list with many duplications. These include journals central
to economics, psychology, management science, economics, statistics,
marketing, etc. About eighty seem to be central to IEn.
Prof. Khalil to furnish list of 'runs' in IEn journals. Library
holds 50 of 58 IEn-related journals in one list, & 99/115 in list two.
Library holds over 42,000 volumes in relevant fields and over
1,600 closely relevant to IEn. Library purchases in IEn for
1983-84 exceeded \$9,400. Est. backfilling cost, \$14,072, one time.
Est. Annual increment: Journal Subscr. - \$2,035; Books - \$1,000.
Laboratory Equipment: *(\$1369 in Subsc. already made.)

IEn has 22 Hazeltine terminals and assoc. equipment, plus hard-
wired connections to Univac.* IEn shares a PC laboratory with
20 stations and substantial assoc. equipment. IEn has a computer
aided design laboratory built around the Harris 800 super-mini-
computer system and includes sophisticated graphics and multi-terminal
capability. Above facilities generally are shared.

Department also has six small laboratories in Work measurement,
Work physiology, Human Factors, Ergonomics, Microcomputers,
and Automation and Robotics. Department sees as minimally equipped now but
as needing about \$250,000 in sophisticated equipment over next five years. Expect
80% or more from gifts and grants. Estimate needed accessories which we must fur-
nish at about \$10,000 in new money per year. *Shared, but IEn is major user.

Space:

IEn now has almost 8200 square feet of space in the East Wing
of the MacArthur Engineering Building, but needs to allot desk
space for incoming Ph.D. level students.

Concentrations will be offered in Ergonomics/Human Factors Engineering and in Production/Productivity Engineering. All students will take a common core, plus area courses. Programs may be individualized, and may include cognate courses in other disciplines, plus Statistics, Oper. Res., Ergo/Hum Factors, etc

Qualified Faculty Members in Each Concentration:

Ergonomics: Khalil*, Asfour*, Rabie, Wiener*, Goldberg, Kurucz*, Moder*, Sumanth*,
TEA in BioMed Eng.

Production/Productivity Eng'g: Sumanth*, Rodriguez*, Adaniya, Kang, Khalil*,
Rabie, Moder*, Omachonu (Jan., 86).

(Regular IEn faculty, underlined. Graduate Faculty (*).

Graduate Assistantships:

IEn has four TAs and requests four more, to be added over first three years of program. Research Assistantships as support for additional students usually will need tuition waiver grants, which must be budgeted for.

Faculty Needs:

The Department proposes that one additional experienced faculty member be added who is at the Senior Assistant Professor or Junior Associate level be added in the fourth year, and that Boubekri, who is not a permanent resident, be replaced with someone of equal experience. In both cases, persons who will qualify for the Graduate Faculty should be hired.

Supporting Activity:

Dr. Khalil directs the Ergonomics and Bioengineering Division of the Comprehensive Pain Center. The division staff consists of 3 Ph.D.'s and 3 engineers (M.S. degrees, two are working on their Ph.D.'s, one of them in the final stages of completion). The Comprehensive Pain Center has on its staff 5 M.D.'s that work closely with the Ergonomics and Bioengineering Division. They represent a valuable research and clinical support to the Ergonomics research work. More than 70 additional professionals constitute the staff of the multidisciplinary research team of the Comprehensive Pain Center. Again, these represent valuable support for research work in the field of Ergonomics.

Staff Needs:

Add one-half Secretary in fifth year.

Add one-fourth technician (FTE) in the third year (actually the sum of fractions of several specialists).

Incremental Income/Cost Analysis:

Incremental Income:

<u>Source-</u>	<u>First Yr.</u>	<u>Second Y.</u>	<u>Third Yr.</u>	<u>Fourth Y.</u>	<u>Fifth Yr.</u>
Student tuition	38,880 (5)	38,880	38,880	38,880	38,880
(@ \$7,776 for		38,880(5)	38,880	38,880	38,880
24 credits.)			38,880(5)	38,880	38,880
				38,880(5)	38,880
	\$38,880	77,760	116,640	155,520	155,520

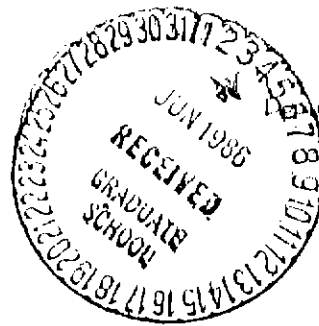
Incremental Expense:

Added Fac. (Sal. + .5OH)			54,000	54,000	54,000
Add TAs (S&T)	27,552	27,552	27,552	27,552	27,552
(7,776 + 6,000)		13,776	13,776	13,776	13,776
			13,776	13,776	13,776
Add Clerical (S&.5OH)				($\frac{1}{2}$)	10,500
Add Technician (S&.5OH)		($\frac{1}{3}$)6,750	6,750	6,750	6,750
Add Lab Equip- ment (Extras)	3,000	6,000	10,000	5,000	5,000
(Major items presumed to come from gifts and grants)					
Library (Backfill once + Jour. & books)	14,072	---	---	---	---
Jour. Subs.	664	664	664	664	664
Books	1,000	1,000	1,000	1,000	1,000
Space	---	---	---	---	---
Supplies (Off. & Lab)	500	1,000	1,500	1,500	1,500
Travel	1,000	2,000	2,000	2,000	2,000
Total Incr. Cost	47,188	51,992	131,018	126,018	136,518
Net Marginal Eff. (8,308)		25,768	(14,378)	29,502	19,002

Absolute Cost:

At asymptotic enrollment of 20 FTE students, each taking an average of three courses each term and two in the summer, assuming a class size of 10 students, and a two course faculty load, six sections must be covered each term and four each summer. This is equivalent to adding three faculty members to the present staff, although graduate assistants will relieve present faculty of many chores so that they can teach more at the graduate level. If salary and overhead amount to about \$50,000 per FTE the true cost of the program is approximately \$180,000 per year (\$150,000 in salary and OH, plus approximately \$30,000 per year in other U-M expenses).

Net Actual Cost thus is approximately \$43,000 per year (\$180,000 less \$136,518 in income).



Department of Neurological Surgery
 1501 N.W. 9th Avenue
 Miami, Florida 33136
 (305) 547-6946

MEMORANDUM

TO: GRADUATE SCHOOL - PHYSICAL SCIENCE SUBCOMMITTEE

FROM: HUBERT L. ROSOMOFF, M.D., PROFESSOR AND CHAIRMAN *HR*

SUBJECT: EVALUATION OF PROPOSED IE PHD PROGRAM

DATE: 23 MAY, 1986

I feel privileged to comment and do wish to support the application of Dr. Tarek Khalil to establish an IE PhD Program at the University of Miami. The addition of graduate students at this level of education would be welcomed in the Ergonomics Section which Dr. Khalil directs in the Department of Neurological Surgery at its Comprehensive Pain and Rehabilitation Center. The Ergonomics Section has been an ongoing Unit for the past three years and has been a major addition to the research effort and its clinical application for patients with pain, and, in particular, the subject of low back pain. Low back pain is the most costly of all health care problems approaching over 70 billion dollars of cost per annum with many problems still unsolved as to the proper diagnosis and management. The biggest impact of this burden is obviously to labor and industry and it is listed among the first five most important industrial injuries by NIOSH. The liason between Industrial Engineering and the Department of Neurological Surgery serves as the only example of an integrated effort to attack all aspects of this problem wherever it may be found. It is truly a holistic approach. The engineering of low back and musculoskeletal disorders is obviously a prime target for Dr. Khalil and his Department and his ability to further his efforts in this direction is enhanced by our association and clearly this is a mutually rewarding effort.

You should know that the Department of Neurological Surgery has already invested more than \$500,000 in support of Dr. Khalil and funding now being sought or under negotiation will far exceed this amount. I suspect our contribution is equal to, if not more than, the University's support and I respectfully submit that the University should match, if not exceed, those funds which this Department applies on Dr. Khalil's projects.

The Department of Neurological Surgery has entered a new phase with respect to its neuroscience basic research. We are opening new laboratories in some 5,000 square feet of research space with a budget to exceed \$2,000,000 a year. We will have a unique multidisciplinary team for investigation of central nervous system disorders and Dr. Khalil's program will make a fitting addition to this consortium by adding engineering expertise. We will be sponsoring a post-graduate program,

Page Two

and, therefore, it is quite appropriate to include Industrial Engineering with the other positions that we will be able to offer. I cannot state at this time the funding which will be available for industrial engineering, but I can tell you we are in support of the PhD level program and we will be able to offer space and resources for the students in addition to some level of stipend support. It will be necessary, however, for the School of Engineering to offer its own support to Dr. Khalil, if the total is to meet the expectations of the Program.

I cannot overemphasize the research, educational and clinical-industrial importance of these programs. Work physiology and occupational biomechanics are the topics for the 1980's and 1990's which have been targeted for their importance. The fertilization and cross-fertilization which the integration of industrial engineering with medicine and behavioral science which the Department of Neurological Surgery offers is all important to this effort. The multidisciplinary approach which has been established between our two Departments is unique in this country and every effort must be made to support its present and future efforts which, with your support, will establish this unit as a center of excellence for the University of Miami and a prototype for the nation.

HLK/rc
052786



February 1, 1985

TO: Dr. David L. Wilson, Vice President for Research
and Dean of the Graduate School (Interim)

FROM: ~~Dean, College of Engineering~~

SUBJECT: Ph.D. Program in the Department of Industrial
Engineering

I am pleased to inform you that the Faculty of the College of Engineering at its meeting on January 30, 1985, unanimously voted to approve and forward the attached proposal for a Ph.D. program in the Department of Industrial Engineering.

I cannot overemphasize the strong need for this program in South Florida and the necessity to process this proposal in a timely manner to retain our competitive edge over other institutions in South Florida.

Should you need any additional information, please contact the department chairman, Dr. Tarek Khalil.


Norman G. Einspruch

NGE:smp
cc: Dr. William F. Lee
Dr. Jo Anne K. Hecker
Dr. Carol V. Truss
✓Dr. Robert Zaller

College of Engineering
PO. Box 248294
Coral Gables, Florida 33124
(305) 284-2404

Faculty Senate Action #87010
Class B Legislation

At its meeting of April 20, 1987, the Faculty Senate approved a Doctor of Philosophy (Ph.D.) degree in Ergonomics with the joint and formal participation of the Department of Industrial Engineering, College of Engineering, Department of Management Science, School of Business, and the Department of Neurological Surgery, School of Medicine, subject to the following four conditions:

1. That a supervisory committee be established composed of two members from the Department of Industrial Engineering, which shall house the program, and at least one member for each the Department of Management Science and the Department of Neurological Surgery. This committee shall be responsible for determining recruitment methods, admissions, doctoral committee composition, and all other policies related to the doctoral program in Ergonomics.

2. That admissions to the program be initially restricted to three students per year.

3. That students not be admitted to the Ph.D. program until assured of adequate resources, as specified in item (b) of the confidential report of the Senate Council dated April 17, 1987.

4. That this approval, in accord with Graduate Council and Senate policies, is provisional requiring a formal review during the third year following approval to determine if the required conditions have been met.

[This review is due by Spring, 1990. Senate action, following a recommendation from the Graduate Council, is required to remove the provisional nature of this approval. Failure to complete the review, or an unsatisfactory review, shall automatically suspend admission to the program.]

PROPOSAL FOR THE ESTABLISHMENT
OF A
PH.D. DEGREE PROGRAM

TABLE OF CONTENTS

1. Graduate School Reports and Memoranda
2. Outside Consultants Report
3. Revised Ph. D. Curriculum Structure
4. IEN Faculty 1986
5. Update of Department's Activities 1985
6. Original Proposal for the Establishment of a Ph. D. Program (1984-1985)

GRADUATE SCHOOL

REPORTS AND MEMORANDA



M E M O R A N D U M

October 13, 1986

OCT 16 1986

N. G. EINSBRUCH

TO: Dr. John Knoblock, Chairman
Faculty Senate

FROM: Associate Provost for Research
and Dean of Graduate Studies (Interim)

SUBJECT: Proposed Ph.D. in Industrial Engineering

On October 8, 1986 the Graduate Council approved the offering of the Doctor of Philosophy in Industrial Engineering as described in the enclosed material. Note that the Council gave its approval subject to the implementation of four actions over the next few years, including the employment of an additional faculty member, additional teaching assistants and similar provisions.

The Graduate Council also took another action that affects this recommendation. Henceforth, all degree programs approved for implementation will be subjected to a formal review during the third year following their approval to determine if the required provisions have been met. The policy is effective with this proposed new degree.

Please let me know if the Senate requires any additional information from the Graduate Council.

A handwritten signature in black ink, appearing to read "Sidney L. Besvinick". The signature is fluid and cursive, with a large loop at the end.

Sidney L. Besvinick

SLB:nb

cc: Dr. Tarek Khalil, Chairman
Department of Industrial Engineering
✓ Dr. Norman G. Einspruch, Dean
College of Engineering
Dr. Luis Glaser, Provost



SEP 11 1986

N. G. EINSPRUCH

MEMORANDUM

September 8, 1986

TO: Dr. Luis Glaser
Executive Vice President and Provost

Dr. Norman G. Einspruch, Dean
College of Engineering

FROM: Associate Provost and Dean
For Research and Graduate Studies (Interim)

SUBJECT: Proposed Ph.D. in Industrial Engineering

Enclosed is the proposal from the Committee on Programs and Degrees of the Graduate Council which recommends the authorization of the Ph.D. in Industrial Engineering. The attached material also includes a copy of the report submitted by the external consultants who reviewed the program, and the incremental income/cost analysis which had been prepared by the Programs and Degrees Committee.

The report will be presented to the Graduate Council for its consideration at the October meeting. Approval by the Committee and the Council connotes that this is a program of merit and warrants your support in the University's effort to achieve quality graduate programs. If accepted by the Council, it will be submitted to the Faculty Senate for its review and endorsement.

The additional cost for the implementation of the program is approximately \$100,000 per year. The document is being transmitted early in the year so that appropriate budgetary planning can be made to accommodate this new degree program. In keeping with Graduate Council action taken last year, implementation of the program when approved will be on a tentative three-year basis, at the end of which time the program will again be reviewed by the Graduate Council.

A handwritten signature in black ink, appearing to read "Sidney L. Besvinick". The signature is fluid and cursive, with a long horizontal stroke extending to the right.

Sidney L. Besvinick

SLB:vv
Enclosure

(I've proposed next enclosed with this copy)

Graduate School
P.O. Box 248125
Coral Gables, Florida 33124

IEnFIN.TRU

MEMORANDUM
July 24, 1986

To: Dean of the Graduate School and the Graduate Council

From: Physical Sciences Sub-Committee
 Arthur Bassett, Christopher Harrison, Jo Anne Hecker, Co-Ch., Tarek Khalil, James Nearing, Carroll Truss, Co-Ch., Norman Weinberg

Subj: Response to outside reviewers and final recommendations regarding proposed Ph.D. in Industrial Engineering.

Encls: (1) Summary of recommendations, departmental response, and committee response.
 (2) October 17, 1985, Memoranda to Chairman, IEn and to Provost showing Graduate Council actions of October 9th and Sub-Committee Report and Recommendations to the Council.
 (3) Memorandum showing financial support for IEn from Dr. Rosomoff, Chairman, Department of Neurological Surgery.

The Committee met several times to review the report of the outside reviewers (Don B. Chaffin, The University of Michigan and Frank Tillman, Kansas State University) for the proposed Ph.D. in Industrial Engineering, who visited the campus April 10-11, 1986.

The reviewers provided an eight page review, first stating key criteria, then dealing in detail with each of the proposed concentrations. Their report has been reviewed by the Department of Industrial Engineering and by this committee. Enclosure 1 is a summary of the reviewers' recommendations, of the Department's responses, and of this Committee's responses.

The reviewers state, "In summary, the ergonomics research program applied to rehabilitation and occupational health planning is well developed and could support a few Ph. D. students with small incremental costs (some faculty released time, supplies, TA appointments, etc.)."

Regarding the proposed production systems engineering program they say, "The emphasis of this program not being in the traditional manufacturing field is a good direction to take since the laboratory equipment and space required are not available." They recommend an additional senior faculty member in this area, and alleviation of heavy teaching loads through the added person and some TAs. They add, "Because of its emphasis, this program appears to be able to flourish if the research is focused on computer based topics and utilizes industrial sites to conduct experiments."

Regarding cost, they say, "Present external funding for ergonomics is barely adequate to support 3 to 4 Ph. D. students each year." They say of production management, "It appears it will

take at least \$100,000/yr minimum to establish this program and to hire the faculty and GTA's needed. Also the tuition waivers for graduate students represent a cost that must be considered." Also, "A goal for (outside funded research) funding should be at least \$250,000."

They conclude, "The Department has identified two areas that they can excel in, Ergonomics and Production Systems Engineering. We believe with this focus, the available resources and the above mentioned concerns and support requirements that a viable Ph. D. program in Industrial Engineering can be established at the University of Miami."

The committee agrees with this last statement and again supports inauguration of this program subject to the following stipulations, essentially the same three recommended in its original report:

1. Addition of a Professor or a senior Associate Professor in Production Systems Engineering with good research experience by Fall, 1987.
2. Authorization of additional Graduate Teaching Assistantships on the schedule recommended in our original report dated Oct. 17, 1985 (Summary of Data, page 3, and in the recommendations section). Specifically, add two TAs in September, 1987, one in September, 1988, and one in September, 1989.
3. Limitation of post-masters Ph.D. level students to five per year in each of the first two years, with no further admissions unless there has been timely addition of TAs, of the new faculty member, and of budget amounts, adjusted for inflation, as indicated in the Summary of Data referenced above.
4. By this memorandum, the committee calls to the attention of the Dean of the Graduate School the resolution adopted by the Graduate Council on October 9, 1985 (See Page 2 of Encl. 1), which directs the Dean to seek assurances from appropriate authorities that stipulated support will be forthcoming, and to report on this to the Graduate Council.

The Committee

**SUMMARY OF REVIEWER'S RECOMMENDATIONS, DEPARTMENTAL RESPONSE, AND
SUB-COMMITTEE'S RESPONSE FOR IEN PH.D. PROPOSAL**

Standards rec. by reviewers:	U-M re Standards per reviewers	Dept. Response	Sub-Com. response
Methodology educ. requires 3rd level courses, etc. Should have supervisory com. for acad. & res. for students.	ERGONOMICS-OK PROD. S .needs senior person OK	Agree Agree, are doing now	Agree Agree, OK
Need exper. graduate faculty that routinely publishes research.	ERGONOMICS-OK PR.S.-Need Senior person	Agree	Agree
Need external fund-support Ph.D. Program.	ERGONOMICS-OK for 3-4 Ph.D. students/yr Need \$50,000/yr per student. PROD. S.-Max of 5. Need \$50,000/S.	Funding need \$25-30,000/yr. per student, either program.	Agree with Dept.
Released time for research & to work with students. Two course limit.	Two course limit necessary for all Fac. active with students & in research.	Agree.	Agree
Clear focus(s) to Ph.D. Program(s) needed. Feel proposal demonstrates.	OK-Proposal has two clear areas. Should emphasize research & publication.	Agree	Agree
Adequate space & equipment needed.	ERGONOMICS-can support 5 students if technician(1/2), TA support, supplies, travel are adequate. is PROD.SYS MGT ok if it emphasizes *EDP & does experiments at industrial sites.	Agree. Note that new space is coming with eng'g addition. Much equipment being donated. In long term will need \$50-100,000 for misc. equipment to make proper use of gifts. Will need to add 1/2 tech. in 2 yrs.	Agree

*EDP = Electronic Data Processing

Incremental Fund-
required.

Apprx \$100,000/yr.
for faculty & Ph.
D. students plus
outside funding of
about \$250,000.

Agree. Grants=
\$247,000+ with
3 prop. for \$100,
000 pending (+
Dr. Wiener's \$110,
000 grant helps
some)

Agree. Offset
partly by paid
tuition by
companies &
indiv. studs.
Most tuition
must be from
U-M.

New faculty
required

One senior person
in Prod. Systems.

Agree.

Agree. Re-
viewers re-
commend per-
son in Prod.
Sys.; We had
rec. in Erg.
but now agree
with review-
ers.

Succinctly, the true added costs of the IEN program when it is fully in place derive from adding-

(1) A professor or senior associate professor in the first year (approx. \$81,000 (\$50,000 base, plus 23% fringe benefits and 39.5% indirect support services)), plus-

(2) Four Graduate Teaching Assistants (GTA) over three years to relieve faculty for the Ph. D. Program, two the first year, and one in each of the next two years, at \$6,750/yr. in stipend or 27,000 (Tuition waived, but not a true cost in present accounting) plus-

(3) Tuition only waivers to an expected ten Graduate Research Assistants (GRA) whose stipends come from extramural grants and contracts, (a nominal \$75,000 in tuition, but not a true cost), plus-

(4) \$30,000 per year in various added expenses when the program is fully in place.

Total annual 'hard dollar' expenditures after the program is completely phased in thus is about \$132,000, offset by the hard cash tuition from 1/4 of the 20 students, about \$39,000. (Waivers to the four GTAs and to about ten or eleven Graduate Research Assistants do not represent an added expense so long as expenditures need not be increased to accomodate added students.

The net incremental cost is about the same or a little less (132,000 less \$39,000) than the outside reviewers' estimate of \$100,000+ per year. A higher number of paying students, perhaps from local firms, would reduce this, since additional resources would not be required for three to five additional paying students. The value of the work contribution from the added professor and of the GTA's, apart from their teaching, is not included in the calculations, but would offset the cost further. During phase-in years, approximate dollar input requirements are as follows, in 1986 dollars:

	Paying Stud. / Total No.	Added Expense	Tuition (Hard \$)	Net
First year	1/ 5	\$114,072	\$ 7,776	(\$106,300)
Second Year	2/10	107,750	15,552	(92,918)
Third Year	5/15	121,250	39,000	(82,250)
Fourth Year	5/20	121,250	39,000	(82,250)
Thereafter	5/20	131,750	39,000	(92,750)

Note- In one sense the net cost is overstated, since the additional GA's represent a substantial increase in the total teaching and research work performed in the department, whose value is not included in the table. In another sense it is understated, since there will be a substantial shift of higher salaried faculty to do their teaching at the doctoral level instead of at the undergraduate level, as now. Fewer sections with larger class sizes and more teaching from GTA's is the result at the undergraduate level.

Incremental Income/Cost Analysis:

Incremental Income:

Source-	No.	First Yr.	Second Y.	Third Yr.	Fourth Y.	Fifth Yr.
Student Tuition, @ \$7,776 ea. (22+cr)	5	38,880	38,880	38,880	38,880	38,880
	10		38,880	38,880	38,880	38,880
	15			38,880	38,880	38,880
	20				38,880	38,880
Total		38,880	77,760	116,640	155,520	155,520
<hr/>						
'Hard' Dollar Tuition	1	7,776	7,776	7,776	7,776	7,776
	1		7,776	7,776	7,776	7,776
	3			23,328	23,328	23,328
Total		7,776	15,552	38,880	38,880	38,880

Incremental Expense:

Assoc. or full prof.	1	81,000	81,000	81,000	81,000	81,000
GTA's (Stipend Only) (\$6,750)	2	13,500	13,500	13,500	13,500	13,500
	1		6,750	6,750	6,750	6,750
	1			6,750	6,750	6,750
Secretarial (Sal.+FB+Indir.)	1/2					10,500
Technician (Sal.+FB+Indir.)	1/4			6,750	6,750	6,750
Laboratory Equipment, (Minor & Suppl.)		3,000	3,000	3,000	3,000	3,000
Major Lab. Equip. (Expected as gifts)						
Library						
One time backfill of journals & books)		14,072	---	---	---	---
Increase book budget		1,000	1,000	1,000	1,000	1,000
Space		---	---	---	---	---
Supplies, Office & Lab.		500	500	500	500	500
Increase Travel \$		1,000	2,000	2,000	2,000	2,000
Total Incremental Exp.		114,072	107,750	121,250	121,250	131,750
Net (Exp. - Hard \$ Tui.)		106,696	92,198	82,360	82,360	92,870

Total (Absolute) Cost:

Proposal adds six sections each term and four each summer, assumes two course faculty load, and 20 students. The added teaching is equivalent to adding three new faculty members, with four added Graduate Assistants, plus one new faculty member, the actual additions. Add about \$30,000/yr. in miscellaneous expenses. Assume 1/4 of students pay hard dollar tuition.

The net cost of the doctoral program when it is completely phased in is \$131,750 less \$39,000 in hard dollar tuition, or about \$100,000/yr. or a little less. The extra value to the University of the work of the Graduate Teaching Assistants and of the 11 or so Graduate Research Assistants is not calculated, and would reduce the net cost further.

Since a considerable amount of faculty level effort is shifted from the undergraduate to the graduate level, the absolute cost of the doctoral program would be greater by the amount of this hidden shift of resources, while the stimulus to additional research and the value to the University of the presumed increase in faculty publication would reduce the absolute cost.



Department of Neurological Surgery
1501 N.W. 9th Avenue
Miami, Florida 33136
(305) 547-6946

MEMORANDUM

TO: GRADUATE SCHOOL - PHYSICAL SCIENCE SUBCOMMITTEE

FROM: HUBERT L. ROSOMOFF, M.D., PROFESSOR AND CHAIRMAN *HR*

SUBJECT: EVALUATION OF PROPOSED IE PhD PROGRAM

DATE: 23 MAY, 1986

I feel privileged to comment and do wish to support the application of Dr. Tarek Khalil to establish an IE PhD Program at the University of Miami. The addition of graduate students at this level of education would be welcomed in the Ergonomics Section which Dr. Khalil directs in the Department of Neurological Surgery at its Comprehensive Pain and Rehabilitation Center. The Ergonomics Section has been an ongoing Unit for the past three years and has been a major addition to the research effort and its clinical application for patients with pain, and, in particular, the subject of low back pain. Low back pain is the most costly of all health care problems approaching over 70 billion dollars of cost per annum with many problems still unsolved as to the proper diagnosis and management. The biggest impact of this burden is obviously to labor and industry and it is listed among the first five most important industrial injuries by NIOSH. The liason between Industrial Engineering and the Department of Neurological Surgery serves as the only example of an integrated effort to attack all aspects of this problem wherever it may be found. It is truly a holistic approach. The engineering of low back and musculoskeletal disorders is obviously a prime target for Dr. Khalil and his Department and his ability to further his efforts in this direction is enhanced by our association and clearly this is a mutually rewarding effort.

You should know that the Department of Neurological Surgery has already invested more than \$500,000 in support of Dr. Khalil and funding now being sought or under negotiation will far exceed this amount. I suspect our contribution is equal to, if not more than, the University's support and I respectfully submit that the University should match, if not exceed, those funds which this Department applies on Dr. Khalil's projects.

The Department of Neurological Surgery has entered a new phase with respect to its neuroscience basic research. We are opening new laboratories in some 5,000 square feet of research space with a budget to exceed \$2,000,000 a year. We will have a unique multidisciplinary team for investigation of central nervous system disorders and Dr. Khalil's program will make a fitting addition to this consortium by adding engineering expertise. We will be sponsoring a post-graduate program,

Page Two

and, therefore, it is quite appropriate to include Industrial Engineering with the other positions that we will be able to offer. I cannot state at this time the funding which will be available for industrial engineering, but I can tell you we are in support of the PhD level program and we will be able to offer space and resources for the students in addition to some level of stipend support. It will be necessary, however, for the School of Engineering to offer its own support to Dr. Khalil, if the total is to meet the expectations of the Program.

I cannot overemphasize the research, educational and clinical-industrial importance of these programs. Work physiology and occupational biomechanics are the topics for the 1980's and 1990's which have been targeted for their importance. The fertilization and cross-fertilization which the integration of industrial engineering with medicine and behavioral science which the Department of Neurological Surgery offers is all important to this effort. The multidisciplinary approach which has been established between our two Departments is unique in this country and every effort must be made to support its present and future efforts which, with your support, will establish this unit as a center of excellence for the University of Miami and a prototype for the nation.

HLR/rc
052786



MEMORANDUM

October 17, 1985

TO: Dr. Tarek Khalil, Chairman
Industrial Engineering

FROM: Associate Provost and Dean for Research and
Graduate Studies (Interim)

SUBJECT: Proposed Program for Ph.D. in Industrial
Engineering

At the Graduate Council meeting of October 9, 1985, Council voted to recommend approval of the proposed Ph.D. in Industrial Engineering, subject to the following stipulations:

a. Addition of a graduate faculty qualified Associate Professor with experience in a graduate program elsewhere who has strong qualifications in the Ergonomics/Human Factors area. We recommend that this person be in place at the beginning of the second year of the program instead of the fourth year as proposed by the Department.

b. Addition of two Graduate Teaching Assistants in the first year, one in the second year, and one in the third year of the program who, with the additional faculty member will free time for the faculty needed as the number of doctoral students increases.

c. That the number of doctoral level admissions (past the M.S.) be limited to five students in each of the first two years. Further admissions thereafter, beyond a total of 10 FTE doctoral students, is not to be allowed unless there has been timely addition of TAs, of the new Associate Professor, and of budget amounts (adjusted for inflation) as indicated in the Summary of Data.

Dr. Jo Anne Hecker will arrange for two external evaluators to visit campus in the near future to review the proposed program. You may wish to nominate 2 or 3 prominent Industrial Engineering faculty members. If so, please forward their names, addresses and phone numbers to her.

Dr. Tarek Khalil
October 17, 1985
Page 2

For your information, Council also approved the following resolution and asked that I forward it to the Provost.

The Graduate Council is very much concerned that financial and other support for new graduate programs, as stipulated by this Council at the time of their approval, have not been provided. We cite specifically the Ph.D. in Biomedical Engineering, the M.A. in Communication, and the Ph.D. in Economics, all approved since 1981.

We hereby request and direct the Dean of the Graduate School to pursue with the Provost, and with the President if need be, this problem of financial support, to seek assurances that stipulated support will be forthcoming, and to report progress to this Council. We note that oversight of the academic adequacy of graduate programs is a function of the Council, and that enrollment in underfunded graduate programs often should be limited.



Sidney L. Besvinick

SLB:nb
cc: Dean Norman G. Einspruch

Memorandum

October 9, 1985

To: The Graduate Council and Dean of the Graduate School
From: Committee on Programs and Degrees of the Graduate Council
Subj: Report and Recommendations Regarding the Proposed Ph.D.
in Industrial Engineering

1. The Committee met eight times last Spring and early this Fall to study this proposal, with the Department Chairman present at most meetings.

2. We find that space, equipment and library are adequate. More sophisticated equipment is needed. Apparently there is good prospect of acquiring the approximately \$250,000 in equipment via gifts and grants over the next five years. We support the Department's request for a modest U-M contribution each year for accessories and maintenance. Library holdings are good, subject to one-time backfilling and about \$2,000 per year in new journal subscriptions, two-thirds of which are already in place, so that only about \$664 per year additional will be needed. Small increments for office supplies and in travel money for faculty are recommended. Staff and technician needs are minor and are not required immediately.

3. The faculty is small (eight) with only three members on the Graduate Faculty, and five who are relatively new Assistant Professors with little publication yet, including one who will arrive in January. However, two former members of the Department, Professor Earl Wiener who is now in Management Science, and Professor Joseph Moder, former Department Chair, also in MAS, are on the Graduate Faculty and have extensive experience in graduate work. Other Secondary Appointees, who include Professor Charles Kurucz, also on the Graduate Faculty, and several faculty members in the School of Medicine, are working in the proposed areas of concentration, and will contribute experienced research guidance. We recommend one new line at the Associate Professor level to be in place by the second year of the program, and to be qualified upon arrival for Graduate Faculty status. Preferably he or she should have experience in graduate research supervision elsewhere.

The Committee recommends the faculty as marginally adequate, assuming that in the current year several of the junior faculty will be published with articles already submitted.

4. Extramural support includes several hundred thousand dollars annually from the State of Florida to support student tuition supplements. Research grants in 1984-85 exceeded \$107,000. New grants include one from IBM for \$220,000, and over \$37,000 in the form of four small grants. Several proposals are pending.

The Committee recommends extra-mural research support as adequate and likely to grow.

5. In summary, The Committee recommends approval of the proposed Ph. D. in Industrial Engineering, subject to the following stipulations:

a. Addition of a Graduate Faculty qualified Associate Professor with experience in a graduate program elsewhere who has strong qualifications in the Ergonomics/Human Factors area. We recommend that this person be in place at the beginning of the second year of the program instead of the fourth year as proposed by the Department.

b. Addition of two Graduate Teaching Assistants in the first year, one in the second year, and one in the third year of the program who, with the additional faculty member will free time for the faculty needed as the number of doctoral students increases.

c. That the number of doctoral level admissions (past the M.S.) be limited to five students in each of the first two years. Further admissions thereafter, beyond a total of 10 FTE doctoral students, is not to be allowed unless there has been timely addition of TAs, of the new Associate Professor, and of budget amounts (adjusted for inflation) as indicated in the Summary of Data.

6. Early inauguration of this program is strongly recommended in view of state support priorities and considerations, and because we recognize the IEn faculty as likely to develop rapidly. However, we call the attention of the Graduate Council to the apparent problems in funding adequately the BioMedical Engineering Ph. D. program, in that the Council's stipulation that a senior full professor must be brought in very soon after the program was approved in 1981, has not been met.

It may be that the School of Engineering is not able to support both programs to levels this Council deems necessary for them to be adequate academically. We recommend that the Council request assurances from the Dean of the School of Engineering as to which he will support or if he is prepared to support both. Thus, although we urge continuing the approval process for IEn, we recommend that the question of whether the program can and will be supported financially be resolved before students are accepted.

We recommend to the Council, also, the enclosed resolution addressed to the Dean of the Graduate School. It expresses our concern that stipulations accompanying recommendations for approval of the Ph. D. in BioMedical Engineering, the M.A. in Communication, and the Ph. D. in Economics have not been met. The Dean is asked to communicate this concern to the Provost and to the President, and to report back to the Council.

The Committee on Programs and Degrees:

Arthur L. Bassett (New, Fall, 1985)
 Christopher G. A. Harrison
 Tarek M. Khalil
 Pamela A. Ferguson (Term ended, May, 1985)
 James C. Nearing
 Norman L. Weinberg
 Carroll V. Truss, Co-Chair
 Jo Anne K. Hecker, Co-Chair

Resolution of the Graduate Council:

The Graduate Council is very much concerned that financial and other support for new graduate programs, as stipulated by this Council at the time of their approval, have not been provided. We cite specifically the Ph. D. in BioMedical Engineering, the M. A. in Communication, and the Ph. D. in Economics, all approved since 1981.

We hereby request and direct the Dean of the Graduate School to pursue with the Provost, and with the President if need be, this problem of financial support, to seek assurances that stipulated support will be forthcoming, and to report progress to this Council. We note that oversight of the academic adequacy of graduate programs is a function of the Council, and that enrollment in underfunded graduate programs often should be limited.

Summary of Data for Proposed Ph. D. in Industrial Engineering

Current Programs:

UG - 180 Students. Credit Hours, F, 1984-	1,935	
M. S. Students - 35. " "	190	(21 FTE)
Total CH taught	<u>2,125</u>	

Faculty:

Full time - 8 (All Ph.D.)	On Graduate Faculty
Secondary Appointments - 5 (All Ph. D.)	<u>3</u>
	<u>4</u>

Present Teaching Load, FT Faculty - 2.5courses, 7.5Mean C.Hrs.Theses produced - 4 M. S.'s awarded - 26, last 6 yrs.
11, 1984-85 onlyAdaniya, Oscar Ph. D. Georgia Tech., 1983, IEn Assistant Prof.
Ref. Art. & Ch. - None /M.S. Ohio State, 1977 Came Fall, '82.

Books & Monographs - None

Misc. - 1980, 82.

Thesis & Dissert. Com. - "Supervised M.S. Projects" Otherwise, none.

Grants - None. (Proposal goes to DOT in June, one to NSF in Dec., 1985)

GF Asfour, Shihab S. Ph. D. Texas Tech, 1980; M.S. Alexandria Univ., 1976.
Associate Professor.

Art. & Ch. - 80, 80, 80, 82, 83, 83, 83, 84, 84, 84, 1 in press.

Books & Mono. - None.

Misc. - 77, 78, 78, 78, 79, 80, 81, 81, 82, 82, 83, 83, 84, 84, 84, 84,
84, 84.

Thesis & Dissert. Comm. - 4 Chair - 1 In Prog. M, 2; Ch. or Co-C, 3.

Grants - 1981 (in-house Biomed NIH), \$3996; 1982, Amer. Can., \$3625
1982, Dept. of Neurosurgery, Co-PI, \$210,000 (to present)Rabie, A. M. Ph. D. University of Nottingham (England), 1982. MSc Univ. of
Manchester, 1975. Assist. Professor.

Art. & Ch. - 1 submitted

Books & Mono. - None.

Misc. - 83 84 85 (All Conference Proceedings)

Kang, Keebom Ph. D. Purdue, 1984; M.S. 1979, Texas. Assistant Prof.
Art. & Ch. - 2 Submitted. Came, Fall, 1983.

Books & Mono. - None

Misc. - None.

Thesis & Dissert. Comm. - M, 1.

Grants - None, but submitted two in-house last year that were not funded.

GF Khalil, Tarek M. Ph. D., Texas Tech, 1969; M.S.I.E., 1968
Texas Tech. Professor and Chair.

Art. & Ch. - 33 and 6 in press.

Books & Mono. - None.

Misc. - 64.

Thesis & Dissert. Comm. - M - 9 Chair - 7 (includes some at U. Fla.)

Grants - PI or Co-Pi on 6 grants, last in 1980. + 1, 1982 to present (PI).

Omachonu, V. K. Ph. D. (expected) Spring, 1986 M. S. Oper. Res. Columbia Univ. 1983.
M.S. Un. of Miami, Ind. Engg., 1980. Arrives Jan., 1986.

Art. & Ch. - None.

Books & Mono. - None.

Misc. - None.

Rodriguez, Ramon Ph. D. Georgia Tech, 1983; MSOR, Geo. Tech., 1980; MSE Michigan, 1976. Assistant Professor. Came, Fall, '83.

Art. & Ch. - (3 submitted)

Books & Mono. - none.

Misc. - 1977, 1974.

Thesis & Dissert. - Member - 1 Ch. 3 (All at Univ. Metro., Caracas)

Grants - None.

GF Sumanth, David J. Ph. D. Ill. Inst. of Tech., 1979; M.S. 1974, Ill. Inst. of Tech.; M. S. 1967, Osmania Univ. Assoc. Prof. Art. & Ch. - 83, 84. Tenure due. Books & Mono. - 1981, 81, 81, 81 (all manuals), 1984, text. 1bk ~~in press~~. Misc. - 17. Thesis & Dissert. Comm. - M - 1 Chair - 3. Grants - 80-82, \$40,000, PI, NSF. Neg. as Co-PI \$150,000 with IBM. Secondary Appointments - Goldberg, M. L. (Psychologist); Kurucz, C. N. (Management Science), GF; Moder, J.J. (Oper. Res., etc.) GF; Pfaffenberger, C. D. (Organic Chemistry, Med. Sch.) GF; Wiener, E. L. (Mgmt Sci.) GF;

Extramural Funding:

By year. 1978: \$102,000; 1979: \$408,700; 1980: \$93,000; 1981: \$80,700; 1982: \$289,000; 1983: \$455,000 (Incl. \$97,000 State Tuition Subsidies); 1984-85: \$107,700 in hand, plus \$99,000 state tuition subsidy, and \$311,000 under negotiation and likely; 1985-86: State tuition subsidy of ~~\$265,000~~ expected. 13 separate grantors are currently involved. (Recent- Adaniya, \$7,750; Rodriguez, \$7,500 (U-M); Khalil, \$6,000.) Wiener, Sizable NASA grant; Sumanth, telephone confirmation,

Library:

Holdings listed include 100 in one list and 115 in a second list with many duplications. These include journals central to economics, psychology, management science, economics, statistics, marketing, etc. About eighty seem to be central to IEn. Prof. Kalil to furnish list of 'runs' in IEn journals. Library holds 50 of 58 IEn-related journals in one list, & 99/115 in list two. Library holds over 42,000 volumes in relevant fields and over 1,600 closely relevant to IEn. Library purchases in IEn for 1983-84 exceeded \$9,400. Est. backfilling cost, \$14,072, one time. Est. Annual increment: Journal Subscr. - \$2,035; Books - \$1,000. Laboratory Equipment: *(\$1369 in Subsc. already made.)

IEn has 22 Hazeltine terminals and assoc. equipment, plus hard-wired connections to Univac. * IEn shares a PC laboratory with 20 stations and substantial assoc. equipment. IEn has a computer aided design laboratory built around the Harris 800 super-mini-computer system and includes sophisticated graphics and multi-terminal capability. Above facilities generally are shared.

Department also has six small laboratories in Work measurement, Work physiology, Human Factors, Ergonomics, Microcomputers, and Automation and Robotics. Department sees as minimally equipped now but as needing about \$250,000 in sophisticated equipment over next five years. Expect 80% or more from gifts and grants. Estimate needed accessories which we must furnish at about \$10,000 in new money per year. *Shared, but IEn is major user.

Space:

IEn now has almost 8200 square feet of space in the East Wing of the MacArthur Engineering Building, but needs to allot desk space for incoming Ph.D. level students.

Curriculum:

Concentrations will be offered in Ergonomics/Human Factors Engineering and in Production/Productivity Engineering. All students will take a common core, plus area courses. Programs may be individualized, and may include cognate courses in other disciplines, plus Statistics, Oper. Res., Ergo/Hum Factors, etc

Qualified Faculty Members in Each Concentration:

Ergonomics: Khalil*, Asfour*, Rabie, Wiener*, Goldberg, Kurucz*, Moder*, Sumanth*,
 TBA in BioMed Eng. Omachonu
 Production/Productivity Eng'g: Sumanth, Rodriguez, Adaniya, Kang, Khalil*,
Rabie, Moder*, Omachonu (Jan., 86).
 (Regular IEn faculty underlined. Graduate Faculty (*)).

Graduate Assistantships:

IEn has four TAs and requests four more, to be added over first three years of program. Research Assistantships as support for additional students usually will need tuition waiver grants, which must be budgeted for.

Faculty Needs:

The Department proposes that one additional experienced faculty member be added who is at the Senior Assistant Professor or Junior Associate level be added in the fourth year, and that Boubekri, who is not a permanent resident, be replaced with someone of equal experience. In both cases, persons who will qualify for the Graduate Faculty should be hired.

Supporting Activity:

Dr. Khalil directs the Ergonomics and Bioengineering Division of the Comprehensive Pain Center. The division staff consists of 3 Ph.D.'s and 3 engineers (M.S. degrees, two are working on their Ph.D.'s, one of them in the final stages of completion). The Comprehensive Pain Center has on its staff 5 M.D.'s that work closely with the Ergonomics and Bioengineering Division. They represent a valuable research and clinical support to the Ergonomics research work. More than 70 additional professionals constitute the staff of the multidisciplinary research team of the Comprehensive Pain Center. Again, these represent valuable support for research work in the field of Ergonomics.

Staff Needs:

Add one-half Secretary in fifth year.
 Add one-fourth technician (FTE) in the third year (actually the sum of fractions of several specialists).

Incremental Income/Cost Analysis:

Incremental Income:

<u>Source-</u>	<u>First Yr.</u>	<u>Second Y.</u>	<u>Third Yr.</u>	<u>Fourth Y.</u>	<u>Fifth Yr.</u>
Student tuition	38,880 (5)	38,880	38,880	38,880	38,880
(@\$7,776 for		38,880(5)	38,880	38,880	38,880
24 credits.)			38,880(5)	38,880	38,880
				38,880(5)	38,880
	<u>\$38,880</u>	<u>77,760</u>	<u>116,640</u>	<u>155,520</u>	<u>155,520</u>

Incremental Expense:

Added Fac. (Sal.+.5OH)			54,000	54,000	54,000
Add TAs(S&T)	27,552	27,552	27,552	27,552	27,552
(7,776+6,000)		13,776	13,776	13,776	13,776
Add Clerical(S&.5OH)				($\frac{1}{2}$)	10,500
Add Technician (S&.5OH)		($\frac{1}{4}$)6,750	6,750	6,750	6,750
Add Lab Equip- ment (Extras)	3,000	6,000	10,000	5,000	5,000
(Major Items presumed to come from gifts and grants)					
Library (Backfill once +Jour.&books)	14,072	---	---	---	---
Jour. Subs.	664	664	664	664	664
Books	1,000	1,000	1,000	1,000	1,000
Space	-----	-----	-----	-----	-----
Supplies(Off.&Lab)	500	1,000	1,500	1,500	1,500
Travel	1,000	2,000	2,000	2,000	2,000
Total Incr. Cost	47,188	51,992	131,018	126,018	136,518
Net Marginal Eff. (8,308)		25,768 (28,732)	(14,378)	29,502	19,002
<u>Absolute Cost:</u>					

At asymptotic enrollment of 20 FTE students, each taking an average of three courses each term and two in the summer, assuming a class size of 10 students, and a two course faculty load, six sections must be covered each term and four each summer. This is equivalent to adding three faculty members to the present staff, although graduate assistants will relieve present faculty of many chores so that they can teach more at the graduate level. If salary and overhead amount to about \$50,000 per FTE the true cost of the program is approximately \$180,000 per year (\$150,000 in salary and OH, plus approximately \$30,000 per year in other U-M expenses).

Net Actual Cost thus is approximately \$43,000 per year (\$180,000 less \$136,518 in income).

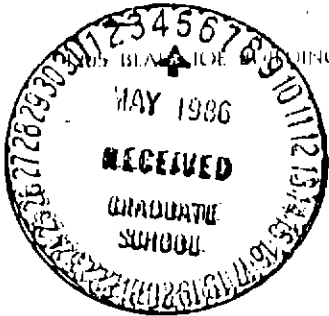
OUTSIDE CONSULTANTS REPORT

APRIL 21, 1986



The University of Michigan

CENTER FOR ERGONOMICS
ANN ARBOR, MICHIGAN 48109-2117



April 30, 1986

Jo Anne K. Hecker
Associate Dean
Graduate School
University of Miami
PO Box 248125
Coral Gables, FL 33124

Dear Dr Hecker:

Enclosed is the report that you requested regarding the proposed Ph.D. program in Industrial Engineering. We hope it is helpful in your evaluation.

Thank you for your sincere interest in assuring that this program, if approved, meets high academic standards, now and in the future.

With best regards!

Sincerely,

Don B. Chaffin, Ph.D.
Professor and Director

DBC:rs
encl.
cc: F. Tillman

SUBJECT: Evaluation of Proposed IE PhD Program - University of Michigan



MEMO TO: Graduate School - Physical Sciences Subcommittee

FROM: Don B. Chaffin, The University of Michigan
Frank Tillman, Kansas State University

DATE: April 21, 1986

This report is based on the review of the proposal from the department and of extensive supporting background materials sent to the reviewers as well as a site visit held April 10th and 11th, 1986. During the visit, we visited with the I.E. faculty, some IE graduate students, the Associate Provost Dr. Besvinick, Dean Einspruch and toured the laboratories and facilities. In the course of discussion with the faculty and administration it became evident that it would be beneficial to refer to specific criteria in distinguishing between the masters level programs now in existence and the proposed Ph.D. in Industrial Engineering. In this regard, these reviewers believe a Ph.D. should provide the following:

1. Depth of education in specific methodological areas to assure that the student is at or near the "cutting edge" of knowledge in an area (ie, this requires third level courses or special topic seminars in methodological areas to be used in the student's research).
2. A supervisory committee structure that includes student counseling and program direction which guides a student into a variety of courses allied with the research area, thus providing a broad perspective upon which to base the dissertation research.

3. A graduate faculty experienced in performing contemporary research in industrial engineering, and who routinely publish in scholarly, refereed journals in the field.
4. An identifiable source of external funds to support the high cost of Ph.D. educational programs.
5. A faculty that has the released time to work with students in developing and executing their research.
6. A focus to the research which will allow the program to be easily recognized by prospective students, faculty and potential sponsors.
7. Space and equipment necessary to perform contemporary research.

The IE faculty have wisely decided to propose their Ph.D. program based on two distinct research areas within the very broad industrial engineering field. These were identified as 1) Ergonomics, with special emphasis on rehabilitation and occupational health and 2) Production Systems Engineering with special emphasis on productivity measurement and production planning. What follows is an evaluation of the potential contributions (and problems) with each of these two proposed areas of concentration.

Ergonomics

This proposed program emphasizes the development of the physiological and biomechanical knowledge necessary to identify, evaluate and manage problems associated with the rehabilitation and return to work of chronic pain patients.

1. The research experience and training of Drs. Khalil and Ashford provide the ability to offer effective 3rd level, special topics courses in the methodological areas of work physiology and occupational biomechanics, and is a major positive factor in recommending this program.

2. The department has established a tradition of requiring students to take courses in supporting disciplines, and no structural barriers appear to exist in such cross-discipline education. The faculty were knowledgeable of appropriate graduate courses in psychology, biomedical engineering and epidemiology which would provide the intellectual breadth necessary to perform contemporary ergonomics research. The secondary appointments of Drs. Wiener and Goldberg further assists in this regard.

3. The extensive and scholarly research and experience of Drs. Khalil and Asford is highly appropriate and supportive of the proposed ergonomics Ph.D. program. They provide the intellectual "critical mass" necessary to assure that the students would receive adequate, timely guidance and intellectual stimulation. Their close research collaboration with Dr. Goldberg, who has a neural-behavioral background, will further facilitate the establishment of a viable Ph.D. educational environment.

4. Present external funding for ergonomics is barely adequate in quantity to support 3 to 4 Ph.D. students each year. As a reference, Ergonomics Ph.D. graduates from Michigan require approximately three years post masters, and an average of \$150,000 each (ie, salaries, laboratory equipment, computer time, supplies, subject fees, etc.). To expand the program at Miami will require additional internal student salary support (TA's and tuition grants) and external funds (see note 6 and below).

5. At present the IE faculty instructional load of between two to three courses/term is too heavy to permit the faculty to recruit and develop a Ph.D. program in ergonomics. No more than 2 courses/term should be

permitted if a faculty member is expected to work with Ph.D. students. Further, if that faculty member has any significant sponsored research funds supporting himself or a Ph.D. student's research, he/she should be released from instruction commensurate with normal guidelines (ie, 20% salary support or 3 Ph.D. students being advised releases a person from teaching a course).

6. The present application of ergonomics by this faculty is to rehabilitation and occupational health. This is unique and important. NIOSH has stated a need for more engineers educated in this field and has special funding initiatives in research and training to promote this area. Federal and state EEOC and rehabilitation regulations are strong incentives for companies and their foundations to support this effort. At best, only five (Michigan, Texas Tech, Auburn, Ohio State and VPI) have IE programs capable of the types of research proposed by this faculty in ergonomics, though many other IE programs are contemplating such an emphasis (as seen at Michigan by the strong demand for Ph.D. graduates in this field).

7. The present space and equipment available in both the School of Engineering and Comprehensive Pain and Rehabilitation Institute is adequate to support at most 5 Ph.D. students in ergonomics, but some incidental costs should be expected (eg, general supplies, office space, TA support etc.). One issue that will arise as the program grows in size is the adequacy of technical support to develop special equipment and software. A dedicated (1/2 time) qualified technician will be needed if more than a few Ph.D. students are expected in this highly experimental area.

In Summary, the ergonomics research program applied to rehabilitation

and occupational health planning in industry is well developed and could support a few Ph.D. students with small incremental costs (some faculty released time, supplies, TA appointments, etc.). A viable program should involve a minimum of five Ph.D. students in ergonomics. Several MS students we met indicated that with some financial aid they would continue their studies toward a Ph.D. in ergonomics. To allow the program to expand beyond five students will require, 1) the addition of a qualified faculty member in ergonomics, 2) a significant increase in external research/training funds, and a proportional increase in TA, supplies space, and technician support.

Production Systems Engineering

This program will concentrate on the softer side of production in the areas of production measurement and production planning. The process of measuring and improving productivity can cover a wide variety of activities and this program will concentrate on those that are not normally considered. The emphasis will include, not only traditional production processes, but will include the service industries, white collar workers and robotic installations as well.

In addition to physical activity, the whole arena of knowledge activity or work will be addressed. There will be a focus to develop the theoretical concepts as well as the practical aspects of productivity measurement. The area of production planning will address such concepts as short term and long term planning, line balancing and just-in-time (JIT) production and inventory control. The emphasis of this program not being in the traditional manufacturing engineering field is a good direction to take since the laboratory equipment and space required are not available.

1. Faculty

Generally the faculty in this area lack a strong background of doing cutting-edge research that results in professional refereed publications. Some of the faculty have published a little at this level which is a good start. These efforts must be encouraged and developed to lead a Ph.D. program. There seems to be a broad enough background in this faculty in conjunction with the Management Science faculty to support this program. The following are needs that must be addressed:

a) To help offset the lack of experience performing this level research, it is recommended that at least one additional senior faculty member be hired that has been successful in publishing in refereed journals and generating funded research. This faculty person along with Dr. Sumanth can anchor this program and give it the "critical mass" to start.

b) There is a strong need to alleviate the heavy teaching loads. Teaching 5 to 6 courses per year simply does not allow enough time to properly advise Ph.D. students. With an additional faculty person and some TA's, these loads can be reduced to no more than 4 courses per year for the senior faculty engaged in research and directing Ph.D students.

2. Laboratories

Because of its emphasis, this program appears to be able to flourish if the research is focused on computer based topics and utilizes industrial sites to conduct experiments.

Moving into the traditional areas of manufacturing such as robotics hardware, automated factories and manufacturing cells, automatic storage and retrieval, automatic guided vehicles and computer aided

manufacturing is not warranted due to the lack of laboratory equipment, space and experienced faculty. The funding to set up these laboratories is enormous.

3. Graduate Students

Graduate student recruiting at the Ph.D. level is difficult. The current cost of \$324/credit hour makes it difficult to attract the good students if they have to pay this out of their pocket. Other schools are heavily recruiting graduate students with lucrative offers. The ability to attract high quality students capable of doing independent research is crucial to the program. The following are needs that must be rectified:

- a) To initiate a tuition waiver for all Ph.D. students and work hard to generate enough funded research to award generous stipends.
- b) Support for more teaching assistants (TA's) is needed to support the program and relieve some of the heavy teaching loads. At least 4 TA's would be required.

4. Program Development

There is a need to initiate several third level or advanced topic courses to challenge the students and faculty. These courses should include review of the current literature and be of the seminar type presentations. These types of courses enable the faculty to explore new areas of interest and to maintain currency in their research areas.

5. Funding Support

It appears that it will take at least \$100,000/yr minimum to establish this program and to hire the faculty and GTA's needed. Also the tuition waivers for graduate students represent a cost that must be considered. Another concern is the critical need of at least a 1/2

time technician to support the labs and research efforts. An important requirement also exists to generate enough outside funded research to support this program. A goal for founding should be at least \$250,000.

6. Size of Program

The number of Ph.D. students in this area of the program should not exceed five at the start. This is primarily due to the lack of faculty, labs and funding support.

General Comments on the Program

In general we feel that a Ph.D. program has inherent benefits for the current undergraduate and M.S. programs. It would enable the faculty to maintain currency in their fields of interest and to develop new areas of research. By having the program, it is easier to recruit new faculty and support their research activities. It appears that there is a need in the geographical area for the Ph.D. program from industry and students. Apparently there is local industry support available for joint research projects.

The philosophy of this program should be driven by research and publications and not to generate funds to support the undergraduate program. The Ph.D. program is an investment in the future. The funds required (100K plus) need to be committed to the program if it is to survive and flourish. We feel the additional funded research generated in the future will more than pay for it.

The department has identified two areas that they can excel in, Ergonomics and Production Systems Engineering. We believe with this focus, the available resources and the above mentioned concerns and support requirements that a viable Ph.D. program in Industrial Engineering can be established at the University of Miami.

A D D E N D U M I

REVISED CURRICULUM

AND

PROGRAM PLAN

(BASED ON CONSULTANTS'

COMMENTS AND RECOMMENDATIONS)

APRIL 15, 1986

ERGONOMICS TRACK

The ergonomics track of the Ph.D. Program will not only prepare the students in the recognized IE subjects, but also will provide them with in depth knowledge in the methodologies and concepts of ergonomics. This track will provide students with a strong background that will enable them to conduct advanced research in Occupational Biomechanics, Work Physiology, Prevention and Rehabilitation of Musculoskeletal Injuries.

CURRICULUM STRUCTURE

Students enrolling in the Ergonomics track of the Ph.D. Program are expected to have completed the following courses (or equivalent) during their Master's Degree Program.

IEEN Core Courses

- IEEN 612 Design of Experiments
- IEEN 641 Applied Operations Research
- IEEN 657 Ergonomics & Occupational Biomechanics
- IEEN 660 Productivity Measurement & Evaluation
- IEEN 547 Computer Simulation Systems
- or IEEN 647 Advanced Computer Simulation Systems

Ergonomics Concentration

- IEEN 557 Man-Machine Systems
- IEEN 558 Industrial Hygiene
- IEEN 659 Work Physiology

Each Ph.D. student will be required to take at least 24 credits out of the following list of Courses:

- IEEN 551 Accident Prevention Systems
- IEEN 655 Advanced Seminar in Ergonomics
- BME 501 Unified Medical Sciences I
- BME 505 Intro to Biomedical Instrumentation
- BME 580 Biomedical Instrumentation
- BME 613 Application of Computers in Medicine
- EPH 621 Chronic Disease Epidemiology
- MAS 606 Nonparametric Statistics
- PSY 606 Multiple Regression & Multivariate Statistics
- PSY 614 Sensory Processes

The student's Advisory Committee may recommend additional courses to suit the student's background and program objectives.

EXAMPLES OF RESEARCH PROJECTS OF INTEREST

Funding
Potential*

- A Functional Strength in Low Back Pain Patients
- A Standardized Methodologies for the Determination of Disability Ratings
- A Error Analysis & Prevention in Highly Automated Aircraft
- A Physiological Limits for Continuous Manual Lifting
- B Work-Rest Schedules for Heavy Manual Lifting
- B Effects of Muscle Stretching on the Effectiveness of the Neuromuscular Control System
- B Quantification of Pain
- B Effects of Functional Electrical Stimulation in Rehabilitation
- C Computerized Biomechanical Models for the Assessment of Musculoskeletal Stresses
- C Computer-Aided Work Station Design

- * A = High Potential for Funding
B = Likely to be Funded
C = Sources of Funding not yet Identified

PRODUCTION SYSTEMS ENGINEERING TRACK

The Production Systems Engineering track of the Ph.D. program concentrates on theory and methodology in the analysis, design, and implementation of systems involved in the production of goods and services. Productivity analysis of techno-economic systems. Planning, scheduling, allocation, and control for productivity improvement and effective utilization of economic, human, and physical resources.

CURRICULUM STRUCTURE

Students enrolling in this track of the Ph.D. Program are expected to have completed the following courses (or equivalent) during their Master's degree program.

IEN 547 Computer Simulation Systems
IEN 601 Advanced Industrial Engr. Concepts
IEN 612/MAS 603 Design of Experiments
IEN 641 Applied Operations Research
IEN 657 Ergonomics & Occup. Biomechanics
IEN 660 Prod. Measure. & Evaluation

Each student will be required to take a minimum of two courses in each of the following four areas:

1. Q.R.

IEN 647 Advanced Simulation
IEN 649 Integer Programming & Network Flows
IEN 651 Nonlinear & Dynamic Programming
MAS 655 Stochastic Processes
MAS 656 Queing Models
MTH 540 Algorithm Design & Analysis

2. Statistics

MAS 602 Applied Multivariate Statistics
MAS 607 Survey Sampling
IEN 649 Forecasting Systems
MTH 621 Mathematical Probability
MTH 624 Nonparametric Analysis
MTH 625 Multivariate Analysis

3. Production Systems

IEN 665 Production Sys. Analysis & Design
IEN 668 Advanced Matl. Handling & Facilities Planning
IEN 605 Advanced Robotics (to be introduced)
IEN 606 Process Planning (to be introduced)

IEN 607 Design for Manufacturing (to be introduced)
MAS 672 Advanced Expert Systems in Mgmt.

4. Productivity Management

IEN 662 Productivity Planning & Improvement
PPA 651 Productivity in the Public Sector
ECO 620 Advanced Econometrics
IEN 610 Technology Mgmt. & Transfer (to be introduced)
ACC 610 Accounting Research Methods & Techniques
GBM 651 Behavioral & Organization Systems

The student's Advisory Committee may recommend additional courses to suit the student's background and program objectives.

EXAMPLES OF RESEARCH PROJECTS OF INTERST

Development of Knowledge Based System for the selection of manufacturing Processes.

Analytical Tools for Productivity Management

Multivariate Output Analysis

Capacity Expansion Models in the Public Sector

Methodologies of Generic Nature for Measuring White-Collar and Knowledge worker

Development of a Computerized Procedure for Equipment Selection in FMS.

Short Term Productivity Planning Model Development Through "Marginal Productivity Analysis

Development of CAD/CAM System for Fixtures used in FMS.

Group Technology Cell Allocation Procedures.

Economic Justification of Equipment and Technologies Through Total Productivity Analysis.

Productivity Measurement of Computer Documentation.

Simulation Optimizations

Artificial Intelligence in the Development of Control Charts

IEN FACULTY
AND
ORGANIZATION CHART



INDUSTRIAL ENGINEERING FACULTY:

Oscar Adaniya, Ph.D., Georgia Tech; Assistant Professor; Applied Operations Research, Engineering Economy, Industrial Development.

Shihab Asfour, Ph.D., Texas Tech University; Associate Professor; Work Physiology, Applied Ergonomics, Biomechanics, Manufacturing Processes.

Bulent A. Bayraktar, Visiting Assistant Professor, Ph.D., New York University; Applied Operations Research, Engineering Economy, Industrial Planning, R&D Management, Technology Transfer

Myron L. Goldberg, Ph.D., University of Miami, Experimental Psychology, Ergonomics, Design of Experiments

Keebom Kang, Ph.D., Purdue University; Assistant Professor; Computer Simulation, Applied Statistics; Engineering Economy; Quality Control.

Tarek M. Khalil, Ph.D., Tech University; Professor and Chairman, Ergonomics/Human Factors, Biomechanics, Production Systems, Occupational Safety and Health.

Charles Kurucz, Ph.D., State University of New York at Buffalo; Associate Professor; Operations Research, Applied Statistics, Design of Experiments.

Vincent Omachonu, Assistant Professor, Health Systems Research, Productivity Engineering, Human Factors.

Carl Pfaffenberger, Ph.D., Purdue University; Professor; Industrial Hygiene, Industrial Toxicology.

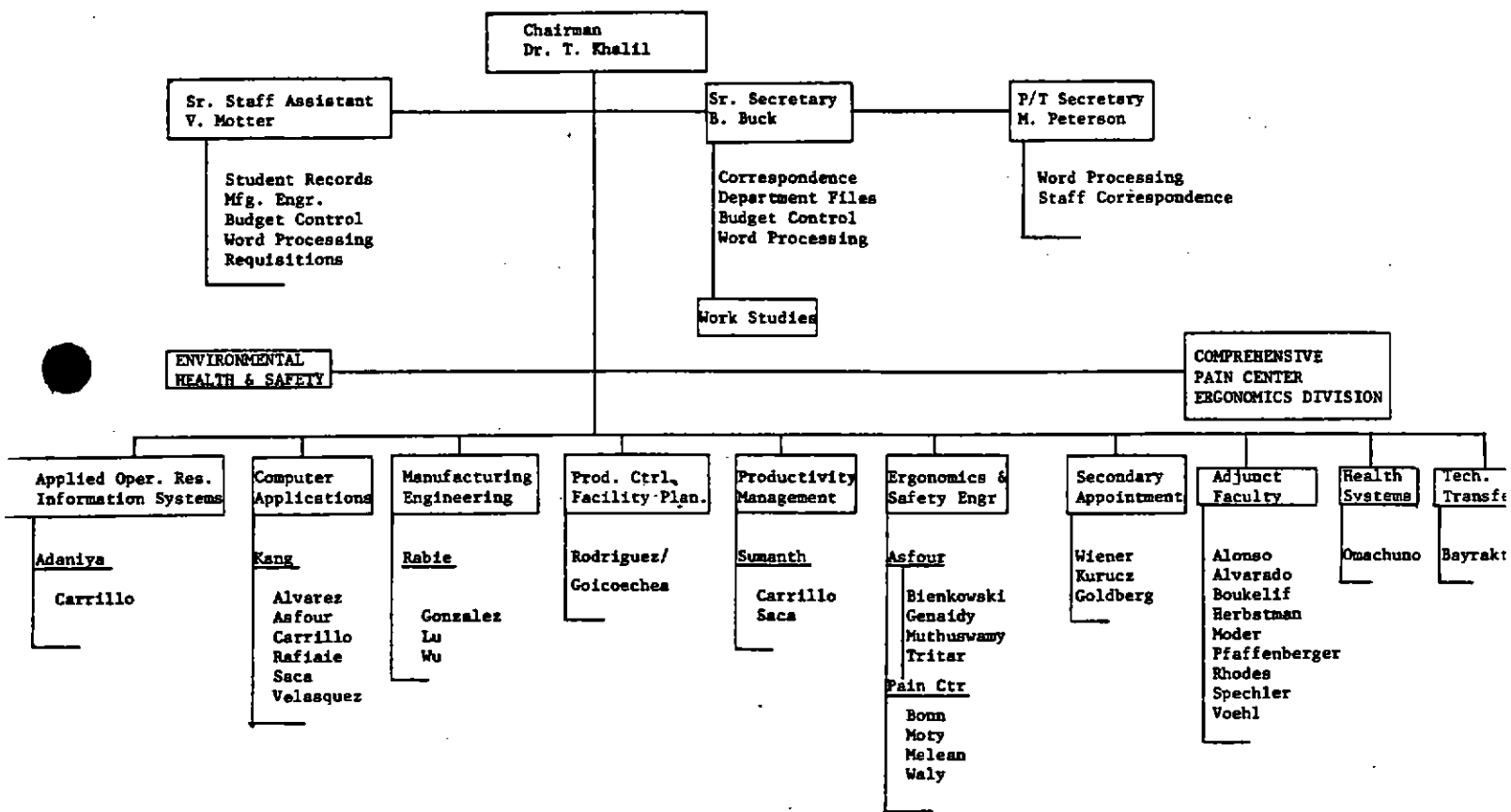
A. M. Rabie, Assistant Professor, Ph.D., Nottingham University (England) computer aided manufacturing, CAD/CAM, industrial robots, manufacturing processes.

Milton Rhodes, D.E., Rensselaer Polytechnic Institute, Adj. Professor Safety Engineering, Environmental Health.

David Sumanth, Ph.D., Illinois Institute of Technology; Associate Professor; Productivity Engineering and Management, Production Planning and Control, Facilities Design, Industrial Cost Analysis.

Earl Wiener, Ph.D., Ohio State University; Professor; Human Factors Engineering, Applied Statistics, Design of Experiments.

ORGANIZATIONAL CHART 1986-87 INDUSTRIAL ENGINEERING



UNIVERSITY OF MIAMI
COMPREHENSIVE PAIN AND REHABILITATION CENTER
AT SOUTH SHORE HOSPITAL

Name & Title

ROSOMOFF, Hubert L., M.D.

Medical Director

Secretary: Leslie Mason

FISHBAIN, David, M.D.

Psychiatry (B-939-2632)

KHALIL, Tarek, M.D.

Chief, Ergonomics

PODRIZKI, Serge, M.D.

Physical Med. & Rehab.

SANTANA, Ramon, M.D. (B-939-2636)

Physical Med. & Rehab.

YSLA, Roy, M.D.

Physical Med. & Rehab.

YSLA, Viola, M.D.

Physical Med. & Rehab.

STEELE-ROSOMOFF, Renee, R.N.

Programs Director (B-939-2631)

Secretary: Frances Stavrides Youmans

BAKER, Virginia, R.N.

Director, Rehab. Services (B-939-1271)

Secretary: Yvonne Roberts

KOHLBERG, Sandy, M.Ed.

Programs Coordinator (B-939-2633)

Secretary: Yvonne Roberts

ADMISSIONS

CONSIGLIO, Donna, Staff Assoc.

HACKETT, Susan, Staff Asst.

ALAVAREZ, Yolanda, Ins. Coord.

ESTEVEZ, Dinorah, Receptionist

BEHAVIORAL/PSYCHOLOGY

ZACHER, Diane, Ph.D.

LABBE, Elise, Ph.D.

LEVINE, Randy, M.S.

McCLEARY, Judy, Ph.D.

ERGONOMICS/BIOFEEDBACK/MUSCLE RE-EDUCATION

ASFOUR, Shihab, Ph.D.

Assistant Chief

GOLDBERG, Myron, Ph.D.

Clinical Supervisor

BON, Ed

JORGE, Michael

MOTY, El-Sayed

SHERIF, Wally

Melean, Lorgia

Zaki, A.

NURSING STATION

Nursing Chart Room

SYLVESTER, Penny, R.N.
Nurse Manager (B-939-2630)
BATHGATE, Patricia, R.N.
Asst. Nurse Mgr. (B-939-2630)
ATWELL, Martha, R.N.
Outpatient Care Coordinator
ALDERSON, Gloria, R.N.
BELHOMME, Hermione, N.A.
BRAUN, Katherine, R.N.
CARR, Brenda, L.P.N.
CHAVEZ, Maria, L.P.N.
COOKE, Shirley, R.N.
FIORE, Rudy, R.N.
GONZALEZ, Iris, G.N.
HANFT, Marjory, R.N.
JACKSON, Willie, N.A.
JEFFERSON, Ruth, R.N.
PILARTA, Olive, R.N.
PITTS, Mary, N.A.
SNELLING, Linda, R.N.

MORALES, Vilma, Ward Clerk
TAYLOR, Helen, Secretary

OCCUPATIONAL THERAPY

MARTINEZ, Myra, Senior Therapist

ARELLANO, June, OTR
ARMSTRONG, Frank, OTR
FALLON, Pat, COTA
ORTEGA, Estela, O.T. Aide
PEREZ, Dania, O.T. Aide
RIVERA, Alma, OTR
RIVERA, Rosenda, OTR
RUIZ, Mary Ana, OTR
SEALY, Joanne, OTR

PHYSICAL THERAPY

JARRETT, Joy, RPT,
Therapist Coordinator (B-939-2634)

ALVAREZ, Ceida, RPTA
BEARD, Marsha, PT Aide
BOSCH, Ann, RPTA
CLERMONT, Pierre, RPTA
FASSBACK, Margaret, RPTA
HALL, Ana, RPTA
MARTINEZ, Gloria, RPT
ROBERTSON, Constance, PT Aide
ROSADO, Josephine, RPT
TRETTO, Felix, RPTA

SECRETARIAL/CLERICAL SERVICES

MARKOWITZ, Ellen
Supervisor (B-939-2635)

BROTONS, Mariana, Pt. Master Files
DELGADO, Gilda, Medical Secretary
DIAZ, Martha Valido, Medical Sec'y
FERNANDEZ, Ketty, Receptionist
FUENTES, Maria Carmen,
Outpatient Appts. Secretary
GARCIA, Millie
Secretarial Aide/Mail Delivery
GONZALES, Diana, Receptionist
MITNICK, Stella, Medical Transcriber
POSADA, Ana, Billing Secretary

VOCATIONAL REHABILITATION

COMPTON, Richard K.
Supervising Counselor

ARIAS, Dina, Counselor
BIALOS, Al, Counselor
WITTKOPF, Marla, Counselor

CHART ROOMS

6th Fl.
7th Fl.
3 West

CONFERENCE ROOMS

6th Fl
7th Fl
3 West

CONSULTS

WERBLIN, Alan C., M.D.
Family Medicine (B-939-1753)

012086 fsy
sv phext2

DEPARTMENT OF INDUSTRIAL

ENGINEERING

UPDATE OF 1985 ACTIVITIES

INDUSTRIAL ENGINEERING

Chairman: Tarek M. Khalil, Professor of Industrial Engineering and Biomedical Engineering; M.S., Ph.D., Texas Tech; ergonomics and biomechanics, production systems, occupational safety and health.

Adaniya, Oscar, Assistant Professor; Ph.D. Georgia Tech; applied operations research, engineering economy, industrial development.

Asfour, Shihab, Associate Professor; Ph.D. Texas Tech; work physiology, applied ergonomics, biomechanics, manufacturing processes.

Bayraktar, B.A., Visiting Assistant Professor, Ph.D., New York University; applied operations research, engineering economy, industrial planning, R&D management, technology transfer.

Kang, Keebom, Assistant Professor, Ph.D. Purdue; computer simulation, applied statistics, engineering economy quality control.

Kurucz, Charles, Associate Professor, Ph.D., SUNY at Buffalo; operations research, applied statistics, design of experiments.

Moder, Joseph, Professor; Ph.D. Northwestern; applied statistics, forecasting and inventory control, PERT/CPM, system analysis methods and applications.

Omachuno, O., Assistant Professor, health systems research, productivity engineering, human factors.

Rabie, A. M., Assistant Professor, Ph.D. Nottingham University (England) computer aided manufacturing, CAD/CAM, industrial robots, manufacturing processes.

Rodriguez, Ramon, Assistant Professor; Ph.D., Georgia Tech; quality control, production planning and control, material handling, applied statistics.

Sumanth, David, Associate Professor; Ph.D., IIT; productivity engineering and management, production planning and control, facilities design, industrial cost analysis.

Wiener, Earl, Professor, Ph.D., Ohio State; human factors engineering, applied statistics, design of experiments.

DEPARTMENT OF INDUSTRIAL ENGINEERING

SUMMARY OF

1985 ACTIVITIES

Faculty and Staff Changes

1. Dr. A. M. Rabie (Ph.D. Nottingham) joined the Faculty in August 1985.
2. An offer was made to Vincent Omachuno, (B.S., M.S. Univ. of Miami, M.S. Columbia, Ph.D. Polytech.) He will be joining the Faculty in the Summer of 1986.
3. Dr. N. Boubekri left the Department to return to his native country of Algeria because of military commitment.
4. Dr. R. Rodriguez took a study-leave this spring to attend to personal and family obligations in Venezuela.
5. Dr. B. Bayraktar (Ph.D. New York Univ.) joined the Faculty this spring on a visiting status.
6. Dr. Earl Wiener returned from a sabbatical year with NASA.
7. Dr. Carl Pffafenberger joined Dade County Department of Environmental Resources. He became an adjunct professor with the Department in the Fall of '85.
8. Dr. Joseph Moder took advantage of an early retirement program. He remains as a part-time professor with Management Science and as an adjunct faculty with the Department. He is still active in teaching 2 courses/semester and graduate student thesis committees.
9. Dr. Charles Kurucz is on a sabbatical leave this year. He will be returning to the University in the fall of '86.
10. Dr. Myron Goldberg (Ph.D. Univ. of Miami) joined the Department on a secondary appointment.
11. Dr. Milton Rhodes, (D.E., R.P.I.), A long-time manager of Environmental Control and Safety, joined the Department this year as an adjunct professor, teaching in the area of accident prevention systems.
12. A list of faculty members, their degrees and areas of interest is attached.

Research

More than 25 proposals for research and training funding were written by the faculty in 1985. A list of these proposals and outcome is given below:

1. IBM (Sumanth, Asfour, Khalil)

A preliminary contract for \$200,000. was issued, but funds were not forwarded because of IBM internal financial and administrative problems.

2. NIHR (Khalil, Asfour, Rosomoff)

Approval for \$250,000. in funding, but was not funded because of agency funds limitations.

3. American Can (Asfour)

The amount of \$9,494. was funded.

4. Research Institution Grant (Rabie, Khalil, Bobekri)

The amount of \$7,500. was funded.

5. American Bankers (Khalil, Sumanth, Asfour)

\$50,000. Our proposal was among the finalists being considered. The company selected Price Waterhouse because of their prior experience.

6. Comprehensive Pain and Rehabilitation Center (Khalil, Asfour)

Funding continued at about \$100,000. level.

7. Fla. High Technology Council Robotics Institute (Khalil, Rabie, Katbab, Kabuka)

The amount of \$130,000. was not funded.

8. Burger King Corp. (Khalil)

The amount of \$6,000. in support of the graduate program was funded.

9. Frank B. Hall (Khalil, Asfour)

The amount of \$2,200. in support of the graduate program was funded.

10. MOD Comp (Einspruch, Boubekri, Rabie, Gottlieb)

The amount of \$40,000. for MODAX5 equipment was approved.

11. IBM (Einspruch, Sumanth, Khalil, Gottlieb)
The amount of \$40,000. for 7535 Robot and PC was approved.
12. Phosphogypsum Institute Research (Sumanth)
The amount of \$15,000. per year was approved.
13. Coulter Electronics (Adaniya, Khalil)
The contract amount of \$15,000. was given to UM Dept of GBM.
14. General Research Support Grant (Asfour)
The amount of \$4,400. was funded.
15. Summer Award in National Science and Engineering (Kang)
This was not funded.
16. Biomedical Research Support Grant (Asfour, Khalil)
This was not funded.
17. Computer Support Grant - 4 proposals (Asfour, Sumanth, Rabie, Goldgerg)
This was not funded.
18. Department of Transportation (Sumanth)
The amount of \$84,725. is pending.
19. Kron Manufacturing (Khalil)
No agreement has been reached.
20. IBM
Ergonomics in the office was not funded.
21. Safety for Tropical Shipping (Asfour, Khalil)
The amount of \$15,000. is pending.
22. A Program for Study for Colombian Universities (Adaniya)
The Amount of \$7,500. was funded.
23. "Error Analysis and Prevention in Highly Automated Transport Aircraft", (Wiener, NASA \$110,000 1st year - 3-year total \$340,000), was funded.

Publications

Every faculty member has published and/or submitted papers for publication. Every faculty member made a presentation in a national and/or international conference.

The departmental faculty published more than 40 publications this past year.

More than 30 presentations were made in international, national and local conferences.

Professional Involvement

The department faculty were very active in professional and community service.

1. Dr. Asfour serves as the current President of the Miami Chapter of IIE. He is on the editorial Board of the International Journal of Industrial Ergonomics.
2. Dr. Adaniya serves as the current VP for the Miami Chapter of IIE.
3. Dr. Sumanth was a nominee to a national office in IIE.
4. Dr. Rabie is in the process of chartering the student chapter of the Society of Manufacturing Engineers.
5. Dr. Khalil served on the NIOSH MHRAC Committee and on the Board of Goodwill Industries.
6. Dr. Wiener serves as Director of Publications for the Human Factors Society.
7. Dr. Rhodes is on the Editorial Board of "Professional Safety".

Graduate Students

1. The Department currently offers financial support to 18 graduate students.
2. Additional 17 graduate students are self-supporting.
3. The M.S.I.E./MBA Program had its second class and continues to be highly successful with more than 26 graduate students.
4. Currently, 4 Ph.D. students are being supervised by the Department Faculty under the Interdepartmental Ph.D. Program.

5. The M.S.I.E. (Manufacturing Engineering Option) at the College of Boca Raton is being initiated. Expected enrollment 12-18 new students.
6. The average GRE scores (verbal and quantitative) for Industrial Engineering students based on 53 students enrolled in IEN between 1981 and 1983 is 1009.
7. Average GRE scores (verbal and quantitative) for admitted and enrolled students in 1984 is 1106. The average verbal score is 449 and the average quantitative score is 657. This figure is based on 10 students.
8. The number of students admitted to IEN Department in the last five years is 76 (7 in 1980, 9 in 1981, 15 in 1982, 24 in 1983, and 21 in 1984).
9. Total number of graduate students in spring 1986 is 61 students.

Office and Laboratory Changes

1. The secretarial staff was upgraded by upgrading the positions and hiring new senior secretary (Mrs. Barbara Buck), senior staff assistant (Ms. Vicki Motter) and part-time secretary (Ms. Margie Peterson).
2. A completely new computerized office support system was installed
3. Laboratories were completely changed and modernized. Plans for expansion of departmental offices and laboratory space are under way.

PROPOSAL FOR THE ESTABLISHMENT
OF A
PH.D. DEGREE PROGRAM



February 1, 1985

TO: Dr. David L. Wilson, Vice President for Research
and Dean of the Graduate School (Interim)

FROM: Dean, College of Engineering

SUBJECT: Ph.D. Program in the Department of Industrial
Engineering

I am pleased to inform you that the Faculty of the College of Engineering at its meeting on January 30, 1985, unanimously voted to approve and forward the attached proposal for a Ph.D. program in the Department of Industrial Engineering.

I cannot overemphasize the strong need for this program in South Florida and the necessity to process this proposal in a timely manner to retain our competitive edge over other institutions in South Florida.

Should you need any additional information, please contact the department chairman, Dr. Tarek Khalil.

Norman G. Einspruch

NGE:smp
cc: Dr. William F. Lee
Dr. Jo Anne K. Hecker
Dr. Carol V. Truss
Dr. Robert Zaller

College of Engineering
PO. Box 248294
Coral Gables, Florida 33124
(305) 284-2404

THE FACULTY MEMBERS OF THE DEPARTMENT OF INDUSTRIAL ENGINEERING PROPOSE THAT A PH.D PROGRAM BE ESTABLISHED IN THE DEPARTMENT. IT IS OUR HOPE THAT THE PROGRAM WILL BE APPROVED IN TIME TO ACCEPT STUDENTS IN THE FALL OF 1985. THE PROGRAM WILL CONCENTRATE ON THE AREAS OF ERGONOMICS/HUMAN FACTORS ENGINEERING AND PRODUCTION/PRODUCTIVITY ENGINEERING. WE BELIEVE THAT A STRONG AND VIABLE PROGRAM IN THESE TWO AREAS COULD BE ESTABLISHED WITH REASONABLE UNIVERSITY SUPPORT.

TABLE OF CONTENTS

	<u>Page</u>
A. RATIONALE FOR THE PROGRAM	1-9
B. PHYSICAL RESOURCES	10
B.1. Library support for Industrial Engineering at the University of Miami	10-12
B.2. Laboratory Equipment	12
B.2.1. Computer Facilities in the College of Engineering	12-13
B.2.2. Laboratory Facilities and Equipment in the Department	13-15
B.3. Space	15-16
C. CURRICULUM	17
C.1. Major Concentrations	17
C.2. Curriculum Structure	17-18
C.3. Existing Courses and Anticipated Changes	19-20
C.4. Cooperation with other Components of the University	20-21
D. STUDENTS	21
D.1. Number of Students	21-22
D.2. Admission and Retention	22-23
D.3. Graduate Assistants	23
E. FACULTY	23
E.1. Curriculum Vitae	23
E.2. Faculty Interests and Capabilities	23-26
E.3. Faculty Research	26-27

	<u>Page</u>
F. ADMINISTRATION	28
F.1. Need for Additional Secretarial Help	28
F.2. Need for Additional Office Supplies	28
F.3. Need for Additional Travel Expense	28

APPENDICES

- I. Documentation of Need for Ph.D.'s in I.E.
- II. Sample Letters of Interest in the
 Ph.D. Program in I.E.
- III. Courses Available to the Students
 in the Ph.D. Program in I.E
- IV. List of Journals and Periodicals Available
 at U.M.Libraries
- V. Faculty Curriculum Vitae
- VI. Summary of Faculty Research and Scholarly
 Activity
- VII. Incremental Cost/Revenue Analysis

A. RATIONALE FOR THE PROGRAM

The request for the establishment of the Ph.D. program in the Department of Industrial Engineering is predicated on two important bases i) The strong need for such a program nationally and locally ii) The capability of the department in initiating such a program.

It is a well recognized fact that there is an international competition involving world resources, their utilization and distribution. The competition among developed as well as developing countries in improving their productivity has created an unprecedented race for the optimal utilization of modern technology and human resources in production systems. The Industrial Engineering field is in the midst of effecting these changes.

The pressures that are expected from the push for the utilization of high technology in industry and our daily activities are expected to increase the demand on highly qualified graduate industrial engineers. Existing information support this contention.

According to the A.S.E.E. Survey of Engineering Faculty and graduate students for Fall 1984, 20% of the Assistant Professor positions in engineering remained unfilled in the Fall of 1983. Industrial Engineering appeared as the only engineering discipline showing a net loss of faculty in the Fall of 1983, 100 faculty positions remained unfilled in Industrial Engineering in the Fall of 1983. Engineering deans around the nation when

questioned in terms of the number of faculty required "to maintain or restore quality in their programs" estimated their needs at three times the current shortfall reported on authorized positions. 129 Ph.D degrees awarded by Industrial Engineering Departments around the country, during the academic year 1982-83. A survey published by the Council of Industrial Engineering Academic Department Heads in 1983 showed that projected need for Ph.D's in I.E. in only 60 schools responding to a national survey was 113. The 1983 Survey of Earned Doctorates published by the National Research Council shows that only 28.3% of Ph.D. recipients in engineering were planning a career in education. It is also a well known fact, that due to the wide variety of fields of specialization in Industrial Engineering, unlike other engineering disciplines, many Ph.D. recipients do not have backgrounds in engineering. This reduces the number available for hiring as Industrial Engineering educators or by industry to affect engineering changes. These figures indicate that we only are supplying about 1/4 of the current demand of Ph.D's needed for education. With the anticipated increased demand of industry for highly qualified Industrial Engineer's that can apply current technology to their modernization program this shortage could be even more dramatic.

In the State of Florida, the need for Ph.D's in Industrial Engineering has begun to be addressed in the last few years the only school having a Ph.D. program in 1981 was the University of Florida with 7 students enrolled and 1 degree granted during that year. The University of Florida's program has been authorized in

the "systems" area. Its emphasis is more in the Operations Research area. In 1983, two other schools reported having a Ph.D. program, the University of Central Florida with 15 students enrolled, and the University of South Florida with 7 students enrolled, with the University of Florida having increased its enrollment to 13 students. The strength of the research programs at these schools (according to the 1984 survey of Engineering College Research and Graduate Study published by the American Society of Engineering Education) are in the areas of facility location and Operations Research (Florida), Computer Applications (Central Florida), and Manufacturing (South Florida). The Post-Secondary Planning Commission of the State of Florida recommended in December 1983, the development of publicly-supported doctoral programs in Engineering for Southeast Florida at the University of Miami, if these programs are not available at Florida Atlantic University. It should be indicated that neither F.A.U. nor F.I.U. currently have engineering programs in Industrial Engineering. Since the Industrial Engineering Department at the University of Miami is the only one in Southeast Florida, there is a strong possibility of receiving the state's support for a doctoral program in Industrial Engineering at the University of Miami.

The Department is currently receiving state support for its undergraduate option in Manufacturing Engineering which is unique in our state.

With Southeast Florida rapidly becoming a center of high-technology industries, it is necessary to offer these industries qualified Industrial Engineering graduates at all levels and also offer their current employees the educational opportunities to further their education and keep up with the developments in their field.

At the University of Miami, the Ph.D. program in Industrial Engineering will emphasize areas of specialization which are not found in the programs currently offered in the State of Florida. They are also not very frequently found in the other doctoral programs offered around the nation. These areas are: Ergonomics/ Human Factors, and Production Systems. The strength of the faculty and the need for Ph.D. level industrial engineers in these areas would make the proposed programs welcome addition. On the other hand any delay in the implementation of this program could result in the University of Miami losing its current leading position in the field in the South Florida area.

Expression of interest in the University of Miami establishing a Ph.D. program in Industrial Engineering has been very high. Appendix II illustrates some evidence of such interest.

The Industrial Engineering Department has made significant progress in its faculty, students and resources over the last few years. Undergraduate enrollment has trippled since 1974 and has doubled since 1979. Faculty numbers have grown from two full-time faculty members to eight full-time faculty members over the last 5 years. The department still enjoys the support and

cooperation of faculty members from other departments who engage in teaching and research areas closely related to industrial engineering. Prominent among these departments is the Department of Management Science.

The Industrial Engineering Department is currently heavily involved in graduate education and research. There are about 45 students currently working towards their M.S. degree. There are 4 students currently working on Ph.D. programs that are supervised by faculty in the Department. Three of these students are in the Interdepartmental Ph.D. program of the Graduate School and one in the Biomedical Engineering program.

We have a bright young faculty with Ph.D's from reputable schools who have strong research interest. A Ph.D. program would help them develop their research and publication interest essential for their future academic development. We also have several senior faculty members (Khalil, Sumanth, Asfour, Wiener, Moder), who are nationally recognized and are very capable of supervising graduate students' research. They all have experience serving on dissertation committees.

The establishment of a Ph.D. program in the department will help in attracting outside funding and in recruitment and retention of bright faculty members and students. This fact is well recognized to the extent that the Accreditation Board for Engineering and Technology (ABET) visitor has recently recommended expanding our graduate program to include the Ph.D. because of its value on improving undergraduate education. The strength of the Department is in the areas of Ergonomics/Human

Factors Engineering and Production Systems/Productivity Engineering. We are currently heavily involved in Ergonomics research in cooperation with the Medical School Comprehensive Pain Center and the Department of Neurological Surgery. Two of our faculty members (Drs. Khalil and Asfour) are directing the Ergonomics Division of the Comprehensive Pain Center. Four graduate students are supported on this program. Dr. Wiener is heavily involved in human factors research with NASA. Drs. Sumanth, Boubekri, Khalil and other faculty members of the Productivity Research Group are involved in Production systems research with IBM Corporation. Two graduate students are supported on this program. Drs. Kang and Rodriguez are involved in projects involving computer applications in production systems. Dr. Adaniya is involved in a number of research projects to enhance productivity of urban and service systems.

The Case of the Ph.D. Program in I.E. at the U. M.

A Ph.D. program in Industrial Engineering will be in the best interest of the University of Miami. Graduates of this program would be highly qualified to serve as faculty members in other universities and educational institutions where the shortage is most noticable (please refer to Appendix I). They can act as ambassadors to attest to the high level of academic quality of the University of Miami.

Graduates could also serve the country's and the state's need for highly qualified engineers to spearhead development in the high technology and space races.

This program will be in the best interest of the College of Engineering, its I.E. department and its faculty. A Ph.D. program in the Industrial Engineering Department would create the proper forum for advanced research and research funding. It would enhance faculty scholarly activities. It would help recruit and maintain quality faculty. It would enhance educational quality. It would enhance the stature of the department, the College and the University and improve the morale of faculty and students in the Department.

The following itemized points may help crystalize the significance and importance of timely consideration of our proposed Ph.D. program:

1. The research capability of the Industrial Engineering Department will be significantly enhanced, bringing in additional

high-quality faculty and students into the department.

2. The national and international image of the I.E. Department, the College of Engineering, and the University as a whole will be increased. This is in line with the university's announced objectives of improving academic quality.

3. The long range plan of making U.M. a high-quality research institution will be achieved by such Ph.D. programs here and elsewhere in the University.

4. F.I.U. does not yet have an Industrial Engineering degree program but they are likely to start one soon. To compete with them in price would be difficult, but to compete with them in the M.S. and Ph.D. programs appears to be not only realistic but absolutely essential for the long-run.

5. The proposed Ph.D. program will help in reducing the faculty shortage problem in our profession. The program will create a strong professional training base rather than serving just the interests of non-academic community.

6. Florida in general, and South Florida in particular, are increasingly becoming the attraction for medium-size industries and businesses. Some examples are IBM, Motorola, Rolls-Royce, Racal-Milgo, Southeast Bank, Burger-King. These organizations will have greater incentive to provide funds for research when we have a Ph.D. caliber student population.

7. We have nationally and internationally recognized faculty in the two tracks of the proposed Ph.D. program.

8. We have very energetic, enthusiastic and productive faculty and their retention is relatively easier if there is an

incentive for them to be a part of a dynamic, research-oriented doctoral program.

We believe that our proposed program compares favorably with those offered in other universities such as at the University of Central Florida, in Orlando, the University of South Florida in Tampa, University of Texas at Arlington, University of Oklahoma at Norman, University of Nebraska at Lincoln, Wayne State in Detroit, University of Southern California in Los Angeles and the University of Houston.

Our areas of proposed concentration are particularly suitable for our faculty strength, resources and location.

B. PHYSICAL RESOURCES

B.1. Library Support for Industrial Engineering at The University of Miami

The following statistics for periodical subscriptions are for the University of Miami Library system, i.e. including the Medical, Law, and Marine Libraries. Statistics on the number of books and the budget, however, are available only for the Richter Library.

Periodicals (University of Miami System)

1. The Industrial Engineering Department has identified 80 periodicals on the library's subscription list that are specifically applicable and/or useful for their work.
2. Two lists of journals containing titles that are pertinent to work in industrial engineering were also checked against the library's subscription list:
 - a. Of the 58 titles on List 1, the library has 50 or 84%. (Appendix IV)
 - b. Of the 115 titles on List 2, the library receives 99 titles (or 84%). (Appendix IV)
3. The libraries at the University of Miami subscribe to the following number of periodicals in fields relevant

to industrial engineering:

Business	856
Psychology	149
Medicine	1,288
Engineering	486
TOTAL	<u>2,779</u>

Government Documents

Richter Library is a full depository for U.S. Government Publications.

Books (Richter Library only)

1. The following list indicates the number of book titles the library owns in twenty-one specific topics relevant to work in industrial engineering.

CAD/CAM	24
Cost Accounting	123
Ergonomics	163
Engineering Economy	51
Finance (International)	41
Forecasting	65
Human Factors	57
Inventory	47
Management	264
Material Handling	49
Metal Cutting	12 (mfg)
Operations Research	39
Plant Layout	32
Production Planning	225
Productivity	38
Psychology, Industrial	62
Quality Control	44
Queueing	35
Robotics	13
Safety	181
Scheduling	36
TOTAL	<u>1,601</u>

2. A count of titles in large subject areas useful for work in industrial engineering is as follows:

Business Administration	5,966
Economics, Industry	1,218
Economics, Production	2,840
Environmental Technology	6,517
Public aspects of Medicine	1,977
Engineering	23,029
TOTAL	42,615

Budget (Richter Library only)

The library purchased at least \$9,408 worth of library materials specifically for industrial engineering in fiscal year 1983-84. A great deal more was purchased in a number of subject areas that are of interest to industrial engineering.

Computer Assisted Services

Richter library offers this very important research service that accesses several hundred data bases in this country.

B.2. Laboratory Equipment

B.2.1. Computer Facilities in the College of Engineering

a. The Clarke Computational Laboratory

This lab is equipped with 22 Hazeltine terminals and 2 Data South printers hard-wired to the UNIVAC 1100/82 at the University Computer Center via two multiplexers. This lab is open seven days a week to be used primarily by engineering students and other students enrolled in engineering courses.

b. Personal Computer (PC) Laboratory

There are 28 specially designed staticns in this lab. Presently, equipments for 20 stations have been acquired and

installed. Each station is equipped with an IBM PC with up to 256 KB memory, two 320 KB disk drives, a color monitor, and a graphics printer. In addition, two HP plotters are available for the whole class. It is intended that this laboratory be linked to the Harris 800 system to enhance its capability. This lab is used mainly for two freshman courses, IEN 124 (Introduction to Computer Programming) and MEN 121 (Computer Graphics).

c. The Computer Aided Design (CAD) Laboratory

The Computer Aided Design (CAD) Lab provides interactive computer aided design facilities for graduate/upper level undergraduate courses and faculty research.

This lab is built around a Harris 800 super-minicomputer system. The 48 bit CPU can have a maximum of 12 MB main memory and can entertain up to 120 terminals. The system includes a single port 474 MB fixed disk drive and a 75 IPS 800/1600 EPI tape unit. In addition to the Harris system, the following graphics facilities are available:

- . One Megatek Whizzard 3355 19 inch 1024x1024 resolution monitor system with high speed, raster display;
- . Four Megatek Whizzard 1650 stations with graphic tablet and for four button cursors
- . One 450 lpm band line printer
- . One CALCOMP 1074 4-pens color plotting system
- . Four alphanumeric terminals with inteactive CRT

B.2.2. Laboratory Facilities and Equipment in the Department

The Industrial Engineering Department has the following laboratories exclusively for its use.

a) Work Measurement Laboratory - This laboratory contains the facilities needed for methods improvement and time study; for example: 16 mm movie projector with frame by frame capability, digital stop watches, a VHS video system complete with a video camera, peg boards, and time study boards.

b) Work Physiology Laboratory - This laboratory contains the equipment needed for the evaluation and measurement of the energy expenditure of a person engaged in physical work activities. The laboratory equipment consists of the following: a Collins treadmill, a bicycle ergometer, an OM-11 Beckman oxygen analyzer, a Goddard carbon dioxide analyzer, a Validyne pneumotach system, mixing chamber, a Narco-Bio 4 Channel physiograph, and muscular strength measurement equipment.

c) Human Factors Laboratory - This laboratory contains the equipment needed for the teaching of the basic measurements in the human factors area. Some of these equipment are for the the measurement of depth perception and hand steadiness. reaction time, tracking ability, psychomotor abilities. Other equipment are used in the teaching of basic anatomy and physiology.

d) Ergonomics Research Laboratory - This laboratory is equipped with high power minicomputer systems dedicated for on-line data acquisition and analysis essential for research in Ergonomics/Human Factors. Two PDP minicomputers comprise the core for the computing power. These two computers are a PDP-11/3 and with A/D converters and PDP-1134 and a high speed line printer. Five computer terminals, and a teletype machine are used for I/O.

The laboratory also has a workstation equipped for vibration research and electromyographic signal processing.

e) Microcomputer Laboratory - A Microcomputer Laboratory equipped with the following computers is available:

1. 2 IBM PC's (256KB, 2 disk drives): teaching and research
2. 1 IBM PC (128KB, 2 disk drives): robot programming
3. 1 IBM PC/XT (256KB, 1 disk drive & 10 MB hard disk): teaching and research
4. 1 Zenith 289 Microcomputer: software teaching
5. 3 Hazeltine 1500 terminals: connected to the University Computer Center
6. 2 Hazeltine Esprit Terminals: connected to the University Computer Center
7. 1 IBM PC/XT (256KB, 1 disk drive & 10 MB hard disk): on order
8. 1 IBM PC (for office use): on order

f) Automation and Robotics Laboratory - This Laboratory is equipped with an IBM7535 Robot, a Shrader-Bellows Motion-Mate Robot and a Seiko Robot. The IBM 7535 is controlled by an IBM PC microcomputer.

B.3. Space

The Department of Industrial Engineering has been recently moved to the East Wing of the McArthur Building and complete renovations have been made to provide sufficient space for teaching, conducting research and administering this growing Department.

The Department now has a total of 8198 sq. ft. as working space. All faculty and administrative offices are located on the second floor of the McArthur Building. The space allocated for both teaching and research is as follows:

Automation and Robotics Laboratory	500 sq. ft.
Micro Computer Laboratory	500 sq. ft.
Human Factors/Work Measurement and Industrial Hygiene Laboratories	2400 sq. ft.
Graduate Seminar and Conference Room	590 sq. ft.
Office Space for Faculty and Administrative Staff	2120 sq. ft.

These newly acquired space and laboratory facilities are considered adequate for the start up of a Ph.D. program in the Department.

C. CURRICULUM

C.1. Major Concentrations

For a Department of our size, a Ph.D. program should be concentrated in areas where we already have strength. Therefore, we propose a program that will specialize in the areas of Ergonomics/Human Factors Engineering and Production/Productivity Engineering (production systems). The program is structured with the philosophy that a Ph.D. student in Industrial Engineering should possess adequate professional knowledge of the entire field and proficient knowledge in his or her area of concentration. Therefore the program is organized around a common core course required of all students in the program, supplemented with a number of specialized courses in the area of concentration. Students may be required to take additional courses beyond the minimum required dependent on their background and experience. The student supervisory committee will have the right to recommend any additional courses it finds to be necessary for the quality education of the student.

C.2. Curriculum Structure

A core program for all Ph.D. students will consist of the following six courses:

IEN/MAS 603	Design of Experiments
IEN 641	Applied Operations Research
IEN 647	Advanced Computer Simulation Systems
IEN 650	Advanced IE Concepts
IEN 657	Ergonomics and Occupational Biomechanics
IEN 660	Productivity Measurement and Evaluation

and three courses from the following groups:

ERGONOMICS/HUMAN FACTORS SUBCORE

IEN 540	Accident Prevention Systems
IEN 557	Man Machine Systems
IEN 558	Industrial Hygiene
IEN 559	Industrial Hygiene Lab.
IEN 659	Work Physiology

PRODUCTION/PRODUCTIVITY ENGINEERING SUBCORE

IEN 562	Production Planning and Control
IEN 570	Engineering Management
IEN 662	Productivity Planning and Improvement
IEN 663	Advanced Materials Handling and Facilities Planning
IEN 665	Production Systems Analysis and Design

The core courses are all fundamental courses, which provide a basis for a broad education in Ergonomics/Human Factors and Production/Productivity Engineering. The candidate should take at least 24 credits after the completion of his/her Masters degree in Industrial Engineering. If the applicant does not have a Master's degree, a minimum of 48 credits have to be taken. Additionally a student has to take any courses recommended by the Ph.D. Committee.

The qualifying examination will be based on the above-listed topic areas. A student should be proficient in at least five of these topics before taking the qualifying examination, usually administered at the end of each year.

C.3. Existing Courses and Anticipated Charges.

The 1984-1985 Graduate Bulletin lists under Industrial Engineering, the following twenty 500-level courses and fifteen 600-level courses:

IEN 505	Industrial Robotics
IEN 506	Special Manufacturing Methods
IEN 512	Quality Control and Reliability
IEN 522	Computer Simulation Systems
IEN 524	Manufacturing Information Systems
IEN 540	Accident Prevention Systems
IEN 551	Special Problems
IEN 552	Special Problems
IEN 553	Special Problems
IEN 554	Industrial Toxicology
IEN 557	Man-Machine Systems
IEN 558	Industrial Hygiene
IEN 559	Industrial Hygiene Laboratory
IEN 560	Industrial Cost Analysis
IEN 561	Manpower Systems
IEN 562	Production Planning and Control
IEN 563	Materials Handling and Facilities Planning
IEN 580	Advanced Engineering Economy
IEN 590	Special Topics in Industrial Engineering
IEN 591	Dean's Seminar: Entrepreneurship
IEN 603	Design of Experiments
IEN 641	Applied Operations Research
IEN 650	Advanced Industrial Engineering Concepts
IEN 657	Ergonomics and Occupational Biomechanics
IEN 659	Work Physiology
IEN 660	Productivity Measurement and Evaluation
IEN 661	Forecasting Systems
IEN 662	Productivity Planning and Improvement
IEN 663	Advanced Materials Handling and Facilities Planning

IEN 665 Production Systems Analysis and Design
IEN 691 Industrial Engineering Seminar
IEN 692 Industrial Engineering Seminar II
IEN 693 Special Problems
IEN 694 Special Problems
IEN 699 Advanced Topics

The number of graduate courses offered each semester is adequate. The Department regularly offers approximately nine 500-level courses and six 600-level courses per semester. The departmental graduate seminar will be strengthened by the required attendance and participation of our Ph.D students. The Department is presently in the process of adding to its program the following courses:

IEN 570 Engineering Management
IEN 647 Advanced Computer Simulation Systems

The students in this Ph.D. program will be able to have a selection of courses from other departments to provide a proper balance of interest and area of specialization. A list of these courses is shown in (Appendix III).

C.4. Cooperation with Other Components of the University

In most quality institutions, Ph.D. students in Industrial Engineering often take advanced courses in Mathematics, Psychology, Computer Science, Electrical and Computer Engineering, Bioengineering, Management Science and Business Administration. The University already has strong programs in these disciplines, and we shall encourage our students to take courses in other departments. Cooperation exists already with the Departments of Management Sciences, Biomedical Engineering,

Epidemiology and Public Health, Neurological Surgery and Psychology. It is expected that such cooperative effort will be strengthened and expanded to other disciplines with the initiation of the Ph.D. program in Industrial Engineering.

D. STUDENTS

D.1. Number of Students

The department has about thirty-five students enrolled in our Masters Programs. We also have 180 students in our undergraduate program. A number of our current and former M.S. students have expressed interest in our Ph.D. program. In addition, inquiries about a Ph.D. degree in Industrial Engineering by mail and phone are constantly being received. Samples of these inquiries are given in (Appendix II). It is estimated that initially there will be only five to ten students enrolled in the Ph.D. program. The number will increase gradually until it reaches a steady state of 20 students by 1990. We expect to award two to four Ph.D. degrees per year. (Appendix VI).

The current students in the Ph.D. program under supervision by the Industrial Engineering Department faculty are:

1. Ms. Elaine Marshall Asfour
 - . G.P.A. in Graduate courses at U.M.: 3.83
 - . Approved for admission by the fellowship committee of the Graduate School.
 - . Working on a Ph.D. Dissertation in Ergonomics/Human Factors.
 - . Dissertation Topic: "Work-Rest Schedules for Video Display Terminals."
 - . Advisor: T. M. Khalil

2. Mr. S. Muthuswamy
 - . G.P.A. in Graduate courses at U.M.: 3.67
 - . Approved for admission by the fellowship committee of the Graduate School.
 - . Working on a Ph.D. Dissertation in Ergonomics/Human Factors.
 - . Dissertation Topic: "Interaction of Work Recovery Schedules for Manual Lifting Tasks."
 - . Advisor: S. S. Asfour

3. Mr. A. Genaidy
 - . G.P.A. in Graduate courses at U.M.: 3.84
 - . Approved for admission by the fellowship committee of the Graduate School.
 - . Working on a Ph.D. Dissertation in Ergonomics/Human Factors.
 - . Dissertation Topic: "A Systems Ergonomics Approach for Human Physiologic Kinetics."
 - . Advisor: S. S. Asfour/T. M. Khalil

4. Mr. E. A. Moty
 - . G.P.A. in Graduate courses at U. M.: 3.0
 - . Approved for admission to candidacy in the Biomedical Engineering Ph.D. Program.
 - . Supported by the Ergonomics Division of the Comprehensive Pain Center
 - . Drs. Khalil and Asfour are members of his supervisory committee which is chaired by Dr. J Kline.

D.2. Admission and Retention Criteria

The admission criteria are as follows:

- i) A Baccalaureate degree in engineering, or a related field
- ii) For students entering the program with an M.S. degree, the average in graduate credits is required to be 3.5 or better.
- iii) A quantitative score of 600 or better on the Graduate record Examination.
- iv) Deficiencies in mathematics, physics, and industrial engineering may be remedied by taking courses at the university. Such courses will not count toward the degree.

The program leading to the Ph.D. degree complies in full with the requirements of the Graduate School. Specifically, the retention criteria and degree requirements are as follows:

- i) Maintenance of an average of 3.5 or better.
- ii) Forty-eight credits of course work at the graduate level, plus a twenty-four credit doctoral dissertation. Students with an M.S. degree must take at least twenty-four course credits.
- iii) One year full-time residence.
- iv) A written qualifying examination based on the core courses and related materials. The examination will be given annually, and students may take it after at least one year of course work. There is no minimum time limitation for students entering with an M.S. degree.
- v) Dissertation and oral defense.

D.3. Graduate Assistants

The number of graduate assistantships and fellowships needs to be increased to attract qualified Ph.D. students. Currently, the Department has four graduate assistantships, and is in need of additional assistants to properly serve its undergraduate program of over 180 students. We envision a total of seven teaching assistantships above and beyond a number of fellowships and research assistantships funded by increased research grants.

(Appendix VII).

E. FACULTY

E.1. Curriculum Vitae

Attached as Appendix V.

E.2. Faculty Interests and Capabilities

The Department of Industrial Engineering currently has seven full time faculty members and one vacant position that was

created by the retirement of Professor Carl Kromp this year. This position is expected to be filled shortly with a highly qualified candidate possessing a Ph.D. degree and with strong interest in research. The department also has 5 University of Miami faculty members on secondary appointments and expects to add a sixth faculty member on secondary appointment very shortly. All 14 faculty members on primary and secondary appointments have Ph.D. degrees from reputable universities. All faculty members collaborate closely in teaching and research and have a wide scope of collaboration with other units of the university.

The two major areas of interest in the Ph.D. program (Ergonomics/and Productions Systems) fit very well within the areas of interest and specialization of the Departmental Faculty.

In the areas of Ergonomics/Human Factors we have faculty that are well recognized nationally and internationally. Drs. Khalil, Asfour and Wiener have in excess of 200 publications in the field. Dr. Khalil has several national awards in the field. Dr. Wiener is chairman of the Publications Committee and Managing Editor of the Human Factors Society Publications. In the past two years Dr. Asfour has published over 10 papers, in the Ergonomics/Human Factors area, in refereed or juried journals. He was recently selected to organize and chair a national conference on Ergonomics and Safety to be held in Miami in 1987. He will also be the editor of a book titled "Trends in Ergonomics/Human Factors" to be published by North-Holland. Drs. Adaniya, Rodriguez, Kunucz and Moder have strong background and interest in the area of statistical design of experiments which

is essential for research in the Ergonomics/Human Factors field.

Faculty from the departments of Biomedical Engineering, Epidemiology and Public Health and Neurological Surgery, interacting with the department of Industrial Engineering provide additional strength in the Ergonomics/Human Factors area. Specially among these faculty members are Dr. Carl Pfaffenberger, Dr. Myron Goldberg. Drs. Khalil and Asfour who direct the Ergonomics Division of the Department of Neurological Surgery and the Comprehensive Pain Center interact directly with over than 70 physicians, psychologists, physical therapists and other professionals who provide the multidimensional knowledge needed for in-depth research in the field of Ergonomics/Human Factors.

It should be emphasized here that the University of Miami is considered to be a leader in the area of Ergonomics/Human Factors teaching and research in the Southeast. It is also considered to be one of the more prominent schools in this field in the U.S.A.

In the area of Production/Productivity Engineering, we have faculty with prominence that are well recognized in this field. Dr. David Sumanth has recently authored a leading book in Productivity Engineering. In his book, which was well received by the Industrial Engineering profession, he advocates formal productivity education in universities, business and industry. He has also authored many publications, in the field of productivity engineering and management and frequently made presentations on this subject to professional groups. Dr. Moder is the author of several internationally acclaimed textbooks and papers in areas pertinent to production systems. Dr. Khalil has several well recognized publications in production systems and

has been a frequent speaker to professional groups on the subject of Technology, Productivity and Technology transfer. Drs. Adaniya, Kang, Rodriguez and Boubekri all have strong background and research involvement in the area of production systems. A Ph.D. program in this area will assist in the career development of faculty in the department and will enhance our productivity and quality in teaching, research and publication.

Incremental cost of faculty and office space is given in Appendix VII.

E.3. Faculty Research

The faculty has been continuously active in research as indicated by their strong publication record (Appendix VI.) Financial support for faculty research activities has exceeded \$400,000 in the past six years. This support was provided by Army Aeromedical Research Laboratory, National Science Foundation, NIH, NASA, American Can Company, Comprehensive Pain Center of Miami, NIOSH, Burger King Corporation and Frank B. Hall Insurance Company. Appendix VI provides a summary of faculty research effort and scholarly activity over the past 5 years period.

The research efforts in the Department have been handicapped by overload in teaching and complete lack of research laboratories and research equipment. The lack of Ph.D. students to participate in our research activities is also a major contributing factor. This fact may have contributed to the loss of some potential funding that did not materialize partially because of a lack of strong research component in the Department

including Ph.D. level research.

The future outlook is that with the recent expansion of our faculty size with an approved Ph.D. program, recent improvement in teaching and research equipment, and the new space we acquired after the renovation of the Engineering Building, there is a definite opportunity to move a significant portion of our research effort to laboratory-based applied research projects. A balanced effort in basic and applied research will strengthen our research program, and we anticipate significant improvement in outside funding. Current research interests include:

- Human-Computer Interface
- Human Factors Engineering
- Work Physiology Theories and Applications
- Exercise Physiology Theories and Applications
- Low Back Pain
- Manual Materials Handling
- Physiological Signal Processing
- Neuromuscular Control Loops
- Work-Station Design.
- Occupational Biomechanics
- Industrial Hygiene
- Safety Engineering
- Vigilance
- Human-Machine Interaction in Air Traffic Control
- Cockpit Design
- Effects of Vibrations on Human Performance
- Productivity Measurement, Evaluation, Planning and Improvement
- Production Planning and Control
- Plant Layout
- Methods Engineering
- Work Measurement
- Inventory Control
- Simulation
- Operations Research Theories and Applications
- Robotics
- Automation
- Flexible Manufacturing Systems
- Technology Transfer
- Management Engineering

F. ADMINISTRATION

F.1. Need for Additional Secretarial Help

The Department currently has two full time secretaries with the assistance of work study students. They are capable of covering the existing load in the department. It is anticipated that, with the increased faculty production in research and publication, another 1/2 time secretary help will be needed. See attached budget in (Appendix VII).

F.2. Need for Additional Office Supplies

Additional office supplies and telephone costs are estimated between \$500 - \$1,500 per year (Appendix VII).

F.3. Need for Additional Travel Expense

The existing travel budget in the department is quite low as was observed by our recent accreditation visitor from ABET.

With the anticipated increase in faculty scholarly work it is estimated that additional travel expenses of \$5,000 will be needed. However the incremental travel cost for the Ph.D. program is expected to be between \$1,000 - \$3,000 per year (Appendix VII).

Appendix I

Documentation of Need
for Ph.D.'s in Industrial Engineering

1983 CIEADH SURVEY

On

Current and Projected New Faculty Positions

Prepared

December 1983

Allen L. Soyster
The Pennsylvania State University

The table given below summarizes the projected faculty needs for IE and IE related departments. The 60 schools participating in this survey are listed in the appendix. The main features of the survey are the following:

- (1) The 60 schools listed in the appendix made 88 new hires for 1983/84. The projected needs for 1984/85 are 113. Hence, this would represent a hiring rate increase of 28%. Even taking into account that some of the projected needs are to replace faculty who are leaving for one reason or other, this would seem to substantiate a significant increase in demand.
- (2) The high growth areas are Automation/Robotics, Manufacturing Processes as well as Human Factors and Management Information System. Projected needs for the first two categories are 44 new faculty. For 1983/84 the actual new hires in these two areas were 23; hence, the demand is nearly doubled. The demand for new Human Factors faculty will also nearly double since in 1983/84 the actual new hires were 8 and the projected demand is 15 for 1984/85. Similarly, the MIS area will grow from 3 to 11, which is even a higher rate of growth.
- (3) The Operations Research area is remaining stable at about 20 new positions for both 1983/84 and 1984/83. The Production/Inventory/Materials Handling area is projecting a decrease, but this may relate to the rather arbitrary rules on how one differentiates among Manufacturing, Automation/Robotics and Production/Inventory/Material Handling.
- (4) The Survey also asked about projected needs for the next three years. Apparently, many respondees have some difficulty (for several good reasons) projecting faculty needs in the longer run. That this is so is seen in the fact that for the next three years the projected faculty needs are only 155. One would expect that this figure should bear some relation with 3 times the 1984/85 needs, i.e. $3 \times 113 = 339$. It does not.

Schools Participation in The 1983 CIEADH SURVEY
on Faculty Hiring and Projected New Positions

University of Alabama in Huntsville	New Jersey Institute of Technology
Arizona State University	North Carolina State University
University of Arizona	Northwestern
University of Arkansas	North Dakota State University
Auburn University	Technical University of Nova Scotia
California Polytechnic	Ohio University
University of California	University of Oklahoma
University of Southern California	Oklahoma State University
Cleveland State University	Oregon State University
Columbia University in NYC	University of Pittsburgh
Cornell University	The Pennsylvania State University
University of Florida	University of Puerto Rico
University of Central Florida	Purdue University
University of South Florida	Rensselaer Polytechnic Institute
Georgia Institute of Technology	Rutgers University
GMI Engineering & Management Institute	Southern Methodist University
University of Iowa	Stanford University
Kansas State University	SUNY at Buffalo
Lehigh University	University of Tennessee at Chattanooga
Louisiana State University	Tennessee Technological University
University of Louisville	Texas Tech University
University of Massachusetts	University of Texas at Arlington
University of Miami	Texas A&M University
University of Michigan	University of Toledo
University of Michigan, Dearborn	University of Utah
University of Western Michigan	Virginia Polytechnic Inst. & State University
Mississippi State University	University of Washington
University of Missouri-Columbia	Wayne State University
University of Nebraska	West Virginia University
University of New Haven	University of Wisconsin-Madison

SURVEY RESULTS

Projected Needs For 1984/1985
113 Positions

CLEASH SURVEY RESULTS

Position Survey

Number of schools responding: 60

Salary Survey

Number of schools responding: 50

Vita Abstracts

Number of schools responding: 31

<u>School</u>	<u>Number of Students</u>
University of Alabama-Huntsville	1
University of Arkansas	2
University of Arizona	4
Auburn University	2
University of California-Berkeley	5
Cleveland State University	1
Columbia University	3
Cornell University	4
Georgia Institute of Technology	6
University of Iowa	3
Iowa State University	1
Louisiana State University	1
Louisiana Tech University	2
University of Massachusetts-Amherst	3
University of Missouri-Columbia	1
University of Nebraska-Lincoln	1
University of New York-Buffalo	4
Northwestern University	6
Ohio State University	5
University of Oklahoma	2
Oklahoma State University	3
Oregon State University	2
University of Pittsburgh	2
Purdue University	18
Rutgers University	1
University of Southern California	2
Southern Methodist University	3
Texas A&M University	2
University of Wisconsin-Madison	2
University of South Florida	1
Texas Tech	1

Total Number of Students: 94

SCHOOL OF INDUSTRIAL AND SYSTEMS ENGINEERING

Atlanta, Georgia 30332-0205

(404) 894-2300

January 4, 1985

Dr. Tarek Khalil
Department of Industrial Engineering
and Systems Analysis
University of Miami
Coral Gables, Florida 33124

Dear Tarek:

As I am sure you are aware it is difficult to come up with precise data on the shortages of industrial engineering faculty in this country. However, the responses that were received from the survey conducted from IE department heads of accredited programs indicated that the shortage is, indeed, very great. With approximately 60% of the department heads responding, they indicate a need for approximately 140 new faculty for next year. This year there are a total of less than 100 PhD's being granted to industrial engineering students in the United States. This, compounded with the growth expected in undergraduate enrollments in industrial engineering as a result of the widening supply/demand gap as documented in the DOL/NSF study of a couple of years ago, leads me to believe that the actual demand is somewhat understated because additional faculty will have to be recruited in order to service the additional students who want to major in industrial engineering. The alternative is, of course, to impose caps on enrollments as we have done here at the Georgia Institute of Technology and as has been done at many other universities. Of course, these enrollment caps have been introduced primarily as a way of compensating for the shortage of faculty that currently exists and make us appear to be unresponsive to the demand for additional engineering graduates in the industrial engineering programs around the country. Hopefully, the supply of well qualified PhD students will be increasing. Certainly we are doing everything in our situation to try to generate more students interested in going to graduate school, but the numbers of PhD students available is relatively small compared to the demand for new faculty. Of course, the opportunities for industrial engineering doctoral students are significantly understated if one considers only the faculty opportunities. Approximately one-half of our doctoral graduates are going to work at private industry and other doctoral graduates of industrial engineering are being used to staff the business schools in this

Dr. Tarek Khalil
January 4, 1985
Page 2

country, as well. Evidence of that exists on your own campus and is replicated in many other programs of business around the country.

I hope this information will be useful to you.

Very truly yours,

Michael E. Thomas
Professor and Director

MET:rl

Iowa State University of Science and Technology Ames, Iowa 50011



Department of Industrial Engineering
212 Marston Hall
Telephone 515-294-1682

January 11, 1985

Dr. Tarek K. Khalil
Department of Ind. Engr. & Systems Analysis
P.O. Box 248294
University of Miami
Coral Gables, FL 33124

Dear Dr. Khalil:

As per our phone conversation on January 9, the information that I have regarding Ph.D. enrollments and graduates per year is derived from a number of sources. As you know, the March issue of the ASEE Journal indicates the number of Ph.D. enrollments and graduates by program within each Engineering School. I have not tallied the Ph.D. graduates from IE from this source but have used the summary data for all Engineering Schools reported. In addition, the American Association of Engineering Societies (AAES) publishes each year the enrollments by level for all engineering curricula by program, by school, and by special group. This information has been circulated to the CIEADH group by Dave Belden, Executive Director of IIE for the past several years. As an additional data point, CIEADH surveys its members each fall and provides that summary data back to its members. Included in that summary is the estimate of new hires in Industrial Engineering based on information provided by each Chairman.

From these sources, the following information is what I have for the Fall of 1983.

Doctoral Enrollments in IE	660
Ratio of Doctoral Degrees to Enrollments for all Engineering	.16
Estimated Degrees	106
CIEADH Estimate of New Hires:	
1983/84	88
1984/85	113

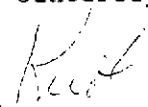
It should be noted that the new hires figure is not adjusted for faculty hires that involve a move from one faculty to another versus new Ph.D.'s, replacements for retirees or those going to industry, or other anomalies in the system. However, the total estimate of new graduates similarly is not adjusted for those going to industry versus those remaining in academia.

Dr. Khalil

Page 2

Given these caveats, it is not difficult to see that the numbers suggest a shortfall of doctoral graduates to meet the faculty needs. These ratios have been in the same relationship for the past several years as I recall the data. I do not have the specific data for past years readily available but they have consistently reflected the same discrepancy between supply and demand. An estimate made a few years ago within CIEADH was that only about 50% of the doctoral degree receiving individuals stay in academia. The shortfall is expected to become more severe in the five to ten year future due to the number of faculty who will reach retirement eligibility within that time frame. Thus, it is our estimate that the shortfall that is being experienced today will significantly increase in severity in the near future. I hope that this has been of some help to you and that your efforts to provide some help to the problem by establishing a Ph.D. program will be successful.

Sincerely,


Keith L. McRoberts, Ph.D., P.E.
Professor and Chairman

KLM:dc



American Society
for
Engineering Education

washington, d.c.

REPLY TO

ENGINEERING DEAN'S COUNCIL

Officers 1982-83

Chairman
Lancel V. Dahlman
Colorado State University

Vice Chairman
William M. Kays
Stanford University

Secretary
Charles C. Brutton
Colorado State University

Directors

Thomas E. Everhart
Cornell University

John E. Tolson
University of Virginia

Richard A. Matula
Louisiana State University

Robert H. Page
Texas A.M. University

Donald E. Rathbone
Mississippi State University

Leighton E. Stinson
Tennessee Technological University

EDC Affiliate Member
Representative

T. M. Ozan
St. Mary's University of San Antonio

Ex officio Board Members

W. Edward Lear
ASEE Headquarters

Joseph C. Hogan
University of Notre Dame

Paul V. Smith
Exxon Research & Engng Co

Paul E. Torgersen
Virginia Polytechnic Institute

Resolution on STUDENT/FACULTY RATIOS in Engineering Education

RECOGNIZING that in the highly technological society of the United States, the quality and quantity of its engineering enterprises largely determine: the survival and prosperity of its technologically-based industries in an increasingly competitive environment; the ability for it to realize economic prosperity with finite resources; the defense of it in an often unstable and dangerous world; and the maintenance of its political influence in times of burgeoning world population.

REALIZING that engineering colleges represent the major institutions in the nation which can develop, nurture, and transform engineering enterprises; that the historically synergistic relationship between engineering education and engineering enterprises has enabled both to flourish and progress; and that the two must remain intertwined in order to continue to achieve their respective goals and to perform their responsibilities;

DETERMINING that engineering education in the United States today is in a crisis mode that is characterized by: an insufficient number of personnel with the appropriate educational and research backgrounds to carry out the engineering educational mission and by lack of funding necessary to respond to the rapid changes required in a technological society. Needs in these areas are visibly manifested: by shortages of qualified faculty candidates available to fill authorized engineering faculty positions; by shortages of authorized faculty positions to adequately meet the educational needs of engineering colleges; and by inadequate salaries to retain faculty currently in academic positions. Needs are also manifested: by undergraduate student enrollments which have increased by 100 percent in the past 10 years while faculty have increased by only 10 percent; by shortages of domestic engineering students pursuing graduate educations; by shortages of technical support staff; and by shortages of laboratory facilities and modern instrumentation;

ASSERTING that the single most important component of engineering education is the quality and number of the faculty; that the faculty are the cornerstones and define the destinies of Universities that the prevention of further erosion in and the enhancement of quality in engineering education must first



American Society
for
Engineering Education

washington, d.c.

REPLY TO:

ENGINEERING DEAN'S COUNCIL

Officers 1982-83

Chairman

Loquel V. Hubbard
Colorado State University

Vice Chairman

William M. Kava
Stanford University

Secretary

Charles C. Britton
Colorado State University

Directors

Thomas E. Everhart
Cornell University

John F. Gibson
University of Virginia

Richard A. Matula
Louisiana State University

Robert D. Page
Texas A&M University

Donald E. Erthbone
Kansas State University

Leighton E. Sisson
Tennessee Technological University

EDC Affiliate Member
Representative

T. M. Ozan
St. Mary's University of San Antonio

Ex officio Board Members

W. Edward Lear
ASSE Headquarters

Joseph C. Hogan
University of Notre Dame

Paul C. Smith
Exxon Research & Engrg Co

Paul E. Torgersen
Virginia Polytechnic Institute

Resolution on STUDENT/FACULTY RATIOS in Engineering Education

RECOGNIZING that in the highly technological society of the United States, the quality and quantity of its engineering enterprises largely determine: the survival and prosperity of its technologically-based industries in an increasingly competitive environment; the ability for it to realize economic prosperity with finite resources; the defense of it in an often unstable and dangerous world; and the maintenance of its political influence in times of burgeoning world population.

REALIZING that engineering colleges represent the major institutions in the nation which can develop, nurture, and transform engineering enterprises; that the historically synergistic relationship between engineering education and engineering enterprises has enabled both to flourish and progress; and that the two must remain intertwined in order to continue to achieve their respective goals and to perform their responsibilities;

DETERMINING that engineering education in the United States today is in a crisis mode that is characterized by: an insufficient number of personnel with the appropriate educational and research backgrounds to carry out the engineering educational mission and by lack of funding necessary to respond to the rapid changes required in a technological society. Needs in these areas are visibly manifested: by shortages of qualified faculty candidates available to fill authorized engineering faculty positions; by shortages of authorized faculty positions to adequately meet the educational needs of engineering colleges; and by inadequate salaries to retain faculty currently in academic positions. Needs are also manifested: by undergraduate student enrollments which have increased by 100 percent in the past 10 years while faculty have increased by only 10 percent; by shortages of domestic engineering students pursuing graduate educations; by shortages of technical support staff; and by shortages of laboratory facilities and modern instrumentation;

ASSERTING that the single most important component of engineering education is the quality and number of the faculty; that the faculty are the cornerstones and define the destinies of Universities that the prevention of further erosion in and the enhancement of quality in engineering education must first

begin with addressing faculty issues; and that a basic factor related to faculty in solving the crisis in engineering education is to determine appropriate student/faculty ratios for engineering education and then to direct efforts toward implementing the same;

HEREBY RESOLVES, as the representative of the nation's engineering deans, that the average student/faculty ratio goal for a suitable engineering education should fall within a range of 12:1 (180 semester credit hours) to 14:1 (210 semester credit hours) for that portion of faculty effort devoted to undergraduate education, within a range of 8:1 (96 semester credit hours) to 10:1 (120 semester credit hours) for the master's programs, and within a range of 4:1 (36 semester credit hours) to 6:1 (54 semester credit hours) for the doctoral programs. Depending on the character and mission of engineering colleges, the student/faculty ratios will differ in accord with the functions of an institution, the involvement of its faculty in academic programming, and the mix of bachelor and graduate degree programs.

Background Information

o Institutional Diversity

The EDC recognizes that the diverse academic environments in which engineering curricula are taught have contributed greatly to the success of the engineering discipline. Each type of college and University offering engineering education, public or private, primarily undergraduate or heavily-involved in graduate education and research, has a primary role to play in maintaining the quality of engineering education. Without such diversity and without stimuli for the continual improvement of each educational setting, the engineering enterprise cannot flourish. The EDC applauds and re-emphasizes its commitment to institutional diversity.

o Resolution Utilization

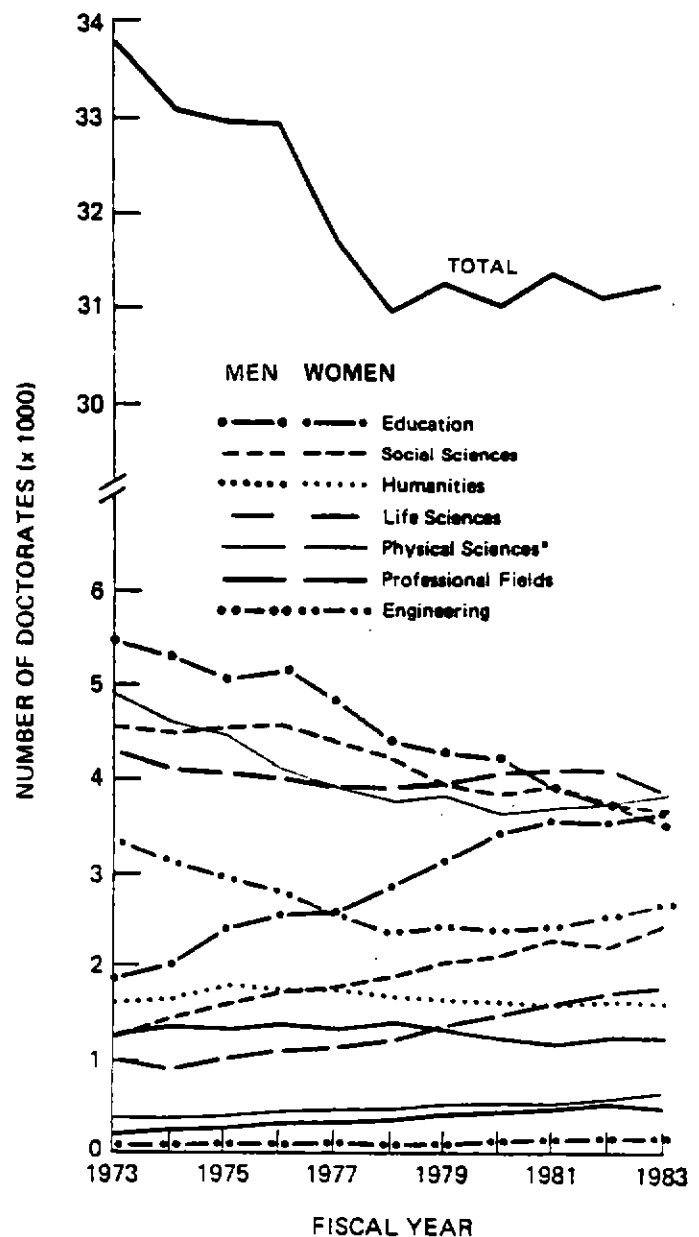
The EDC also recognizes that the recommended student/faculty ratios are, at best, goals which may be used to guide engineering colleges and schools in their achievements. The diverse environments at each institution effectively preclude any realistic attempt from outside the institution to mandate individual ratios which appear optimum. When individual institutions have determined their optimum student/faculty ratios for quality engineering education, they are advised to devise plans of action to implement student/faculty balance. The plans will usually demonstrate the need to limit student enrollment, hire additional faculty, or some combination of both. In any case, solutions to the student/faculty ratio problems will require making difficult decisions and generating support in conjunction with various college of engineering constituencies. Thus dissemination of the issues surrounding student/faculty ratios should be made to a broad range of

HIGHLIGHTS FROM THE 1983 SURVEY OF EARNED DOCTORATES

Presented below are data derived from the Survey of Earned Doctorates, an annual survey of all new doctorate recipients conducted by the National Research Council.* The findings of the 1983 survey are highlighted, along with a statistical profile of the 1983 doctorate recipients and recent data on those individuals planning to enter the U.S. labor force following receipt of the doctorate.

Trends in Doctoral Degrees Awarded, 1973-1983

- U.S. universities awarded 31,190 research doctorates during the period July 1, 1982, to June 30, 1983—an increase of 116, or less than 1 percent, from the 31,074 doctorates granted in 1982. This small upward movement represents a continuation since 1977 of slight variations in the number of doctorates received within the range of 31,000 to 32,000.
- The strong growth patterns across all fields characteristic of the 1960s began to diverge in the early 1970s; the numbers of physical sciences, engineering, and humanities Ph.D.s declined while the number of doctorates in fields such as the life sciences continued to increase through the 1970s.
- While the total number of doctorates has remained relatively constant since 1977, the number of female Ph.D.s has steadily increased—now at 10,485, or 34 percent, of 1983 doctorate recipients. These figures represent all-time highs for women in both number and percent of total doctorate recipients.
- The number of male doctorate recipients decreased by 294, or 1 percent, from the 1982 total, continuing a slow decline from the peak years of the early 1970s. However, the number of male Ph.D.s in the physical sciences and engineering appears to have recovered with both fields showing steady increases from 1980 to 1983.
- Education, accounting for over one-third of 1983 female doctorate recipients, continues to be the most populous field for women. Women in the physical, life, and social sciences have consistently increased in number from 1973 to 1983, each field increasing by between 40 and 50 percent during the 11-year period.



* Includes mathematics and computer sciences.

Number of Doctorates Awarded by U.S. Universities by Broad Field and Sex, 1973-1983. SOURCE: National Research Council, Office of Scientific and Engineering Personnel, Doctorate Records File.

*The conduct of the Survey of Earned Doctorates is supported by the National Science Foundation, the Department of Education, the National Endowment for the Humanities, and the National Institutes of Health. Questionnaires are distributed through the office of the graduate dean of each doctorate-granting institution in the U.S. and are filled in as the individual completes all requirements for the doctoral degree. A more detailed presentation of the survey results can be found in *Summary Report 1983, Doctorate Recipients from United States Universities*. Copies are available without charge from the Doctorate Records Project, Office of Scientific and Engineering Personnel, National Research Council, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.

Statistical Profile of Doctorate Recipients by Field of Doctorate, 1985

	1983 Total	Physic and Astronomy	Chemistry	Earth, Atmospheric and Marine Sciences	Physical Sciences	Mathematics	Computer Sciences	Engineering	EMP Fields	Biochemistry	Other Biociences	Biociences	Health Sciences	Agricultural Sciences	Life Sciences	
Number in Field	31,190	1,042	1,759	637	3,438	701	285	2,780	7,204	646	3,086	1,732	636	1,172	3540	
Male	X(1) 86.4	92.9	83.1	86.8	86.4	83.9	87.4	93.5	89.7	70.0	66.4	67.0	67.3	87.1	69.0	
Female	35.6	7.1	16.9	15.2	13.6	16.1	12.6	6.5	10.3	30.0	33.6	33.0	32.7	12.9	31.0	
U.S. Citizenship	X	77.9	67.9	77.0	75.7	74.0	58.6	62.5	41.8	59.6	83.4	86.3	85.8	78.1	62.1	79.9
Foreign Citizenship		18.5	29.5	20.0	21.4	23.1	36.4	34.7	53.5	36.6	13.0	11.4	11.7	18.7	35.1	17.4
Unknown		3.6	2.6	3.0	3.0	2.9	5.0	2.8	4.7	3.8	3.6	2.3	2.5	3.1	2.8	2.6
Married	X	59.1	46.7	53.9	59.3	52.7	45.4	61.4	61.2	53.6	54.3	54.6	59.0	70.2	58.4	
Not Married		33.8	49.6	41.6	33.6	42.9	48.9	35.1	32.5	39.1	41.8	41.5	41.6	33.4	25.2	
Unknown		5.1	3.0	6.5	5.0	6.3	6.1	3.5	6.3	5.2	3.9	3.9	3.7	4.6	4.3	
Median Age at Doctorate		32.8	29.3	28.6	31.1	29.3	29.6	30.9	30.8	30.0	29.2	30.1	29.9	33.9	31.8	30.6
Percent with Bacc in Same Field as Doctorate		55.6	80.1	83.3	45.1	75.4	78.0	21.8	74.0	73.0	23.2	64.2	57.4	46.2	36.3	56.3
Percent with Masters		80.5	68.0	38.4	76.3	54.4	74.9	86.0	88.3	70.7	28.0	54.2	49.7	84.7	90.6	62.4
Median Time Lapse From Bacc to Doct																
Total Time	Yrs	9.8	7.2	6.2	8.4	7.0	7.4	8.5	8.0	7.4	6.9	7.4	7.4	10.9	8.5	7.9
Registered Time		6.6	6.4	5.4	6.7	5.9	6.1	6.5	5.7	5.9	6.2	6.2	6.5	5.8	6.1	
Postdoctoral Study Plans X(1)		19.3	48.0	42.6	31.4	42.1	19.5	7.0	14.2	27.8	80.3	63.1	66.1	11.6	16.6	49.4
Fellowship		9.2	15.7	18.4	13.3	16.7	8.1	2.1	3.6	10.2	46.4	33.0	37.0	6.6	4.8	26.7
Research Assoc		7.3	30.9	22.4	17.1	24.0	8.4	4.9	3.7	13.8	23.6	19.8	20.7	3.5	10.8	16.7
Traineeship		1.0	.7	.7	.6	.7	1.3	.0	1.5	1.0	3.1	1.4	1.9	.5	.5	1.4
Other		1.6	.7	1.1	.3	.8	1.7	.0	.5	.7	5.4	6.7	6.3	1.1	.4	4.6
Planned Employment After Doctorate X		74.4	47.2	51.8	63.6	52.6	72.3	87.7	77.5	65.5	14.9	32.3	29.3	81.3	76.9	45.3
Educ Institution		43.8	19.5	9.3	25.3	14.0	55.2	44.9	28.3	24.8	4.3	16.7	14.5	45.6	39.8	23.4
Industry/Business		16.2	23.0	36.8	21.0	29.7	10.8	35.1	37.3	31.0	7.3	7.0	7.1	12.9	16.0	9.6
Government		7.3	6.8	3.2	13.2	6.1	3.7	4.9	8.3	6.8	1.4	4.8	4.2	10.4	16.4	7.1
Nonprofit		6.9	.7	.9	1.7	1.0	.7	.7	1.4	1.1	.5	1.5	1.3	7.4	2.0	3.2
Other & Unknown		3.9	1.4	1.7	2.4	1.7	1.9	2.1	1.9	1.6	1.4	2.3	2.1	5.0	4.6	3.0
Postdoct Status Unknown X		6.3	4.8	5.6	5.0	5.2	8.1	5.3	8.2	6.7	4.8	4.6	4.6	7.1	6.6	5.3
Definite Postdoct Study(1)		14.0	36.5	32.0	22.0	31.5	13.7	4.2	8.2	19.7	69.2	49.9	53.3	8.3	9.5	38.8
Seeking Postdoct Study		3.3	11.5	10.0	9.4	10.6	3.8	2.8	6.0	8.1	11.1	13.2	12.8	3.3	7.1	10.3
Definite Employment		53.6	32.1	40.3	50.9	39.8	54.9	67.0	58.0	49.4	9.9	20.9	19.0	62.3	54.9	31.6
Seeking Employment		20.8	15.1	11.5	12.7	12.8	17.4	20.7	19.5	16.2	5.0	11.4	10.3	19.0	21.9	13.8
Employment Activity After Doctorate																
Primary Activity																
R & D	X(1)	25.4	70.4	77.4	54.0	70.2	37.1	81.8	61.3	62.1	60.9	48.1	69.4	32.3	53.1	47.6
Teaching		39.2	22.4	13.3	22.2	17.6	54.0	23.1	24.5	23.1	21.9	29.5	28.8	34.4	21.3	27.7
Administration		13.6	.9	1.6	3.7	1.9	.5	2.6	1.9	1.8	7.8	3.4	3.8	12.6	2.8	5.4
Prof. Services		13.7	1.2	2.1	8.3	3.4	1.8	2.6	5.3	4.0	4.7	12.2	11.6	12.6	7.0	10.1
Other		3.0	2.4	.8	6.8	2.8	1.3	2.6	2.5	2.4	1.6	2.5	2.4	1.8	6.1	3.6
Activity Unknown		5.1	2.7	4.8	4.9	4.3	5.2	3.2	4.5	4.6	3.1	4.2	4.1	4.3	7.8	5.3
Secondary Activity																
R & D		26.2	17.3	10.9	21.9	15.1	45.2	24.6	22.6	22.3	12.5	28.8	25.5	32.8	20.8	25.4
Teaching		14.5	8.4	3.2	14.3	6.7	22.1	28.8	13.8	12.7	7.8	16.3	13.5	13.7	19.3	16.9
Administration		9.3	7.8	14.5	10.5	11.9	2.1	7.3	8.2	8.9	18.8	11.6	12.3	11.9	8.9	10.9
Prof. Services		7.8	3.6	6.1	6.8	3.6	3.1	4.2	3.3	3.1	4.7	6.0	3.9	9.1	6.2	6.7
Other		2.1	.6	.7	.9	.7	.5	.5	1.1	.8	.0	.8	.7	.3	1.4	.9
No Secondary Activity		37.2	59.7	59.8	42.6	55.7	21.8	29.3	44.6	43.6	53.1	36.3	36.0	26.0	35.7	33.4
Unknown		5.1	2.7	4.8	4.9	4.3	5.2	3.2	4.5	4.6	3.1	4.2	4.1	4.3	7.8	5.3
Region of Employment After Doctorate																
New England	X(2)	6.1	7.8	5.3	3.7	5.6	8.1	5.8	5.3	5.7	4.7	5.7	5.6	5.1	2.5	4.3
Middle Atlantic		14.4	17.9	22.0	5.9	17.5	12.2	21.5	14.1	13.6	20.3	11.9	12.7	13.2	3.9	10.0
East No Central		13.3	7.5	19.5	7.4	13.7	16.3	12.6	11.5	12.7	15.6	13.3	13.5	14.2	9.0	12.5
West No Central		6.2	3.0	6.3	4.6	5.1	7.8	2.6	3.5	4.4	10.9	7.0	7.3	6.1	10.9	8.3
South Atlantic		14.8	14.0	13.8	13.3	13.7	12.5	8.4	11.0	12.1	13.6	19.1	18.8	13.7	12.9	13.9
East So Central		4.3	4.8	1.6	3.7	2.9	4.2	2.6	2.9	3.0	4.7	2.3	2.5	3.8	4.2	3.4
West So Central		8.4	5.7	7.9	18.8	9.9	7.3	10.5	7.7	8.7	3.1	7.8	7.3	8.1	6.8	7.3
Mountain		4.5	5.7	3.1	9.9	5.3	4.2	4.2	6.7	4.9	3.1	3.6	3.5	5.8	5.4	4.7
Pacific & Insular		11.0	17.9	10.3	13.9	13.0	14.0	18.3	15.5	14.6	7.8	10.9	10.6	9.8	8.5	9.7
Foreign		10.0	13.7	5.5	14.5	9.6	10.6	8.9	18.5	13.7	10.9	13.2	13.0	10.6	32.8	19.7
Region Unknown		7.1	2.1	3.9	4.3	3.6	4.9	4.2	5.3	4.5	3.1	5.3	5.1	5.8	3.1	4.1

(1)Percentage of total number in field.

(2)Percentage of doctorates with definite employment commitments.

Doctorate Recipients Entering the U.S. Labor Force

Each cohort of doctorate recipients from U.S. universities is a genuinely international group representing some 122 home countries. In 1983, nearly one-fifth of the 1983 doctorate recipients were non-U.S. citizens, with 16 percent holding temporary visas. Moreover, in fields such as engineering, mathematics, and agriculture, the proportion of non-U.S. citizens is considerably higher—54, 36, and 35 percent, respectively.

Responses to the annual Survey of Earned Doctorates provide information concerning the career plans of doctorate recipients immediately following graduation, including the location of planned postdoctoral activity. Using this information, estimates can be derived of the numbers and citizenship composition of those Ph.D.s planning to enter the U.S. labor force. Virtually all of the U.S. citizens and non-U.S. citizens with permanent (immigrant) visas planned to enter the U.S. labor market following the Ph.D. In 1983, approximately 58 percent of temporary (student) visa holders planned employment or further study in the United States. Postgraduation plans of doctorate recipients entering the labor force for the major fields displayed in the table below are as follows:

- The proportion of all new entrants still seeking appointments at the time of doctorate grew steadily through the

1970s, from 19 percent in 1969 to 27 percent in 1983. While the proportion seeking postdoctoral study has remained stable (3 to 5 percent), the percentage seeking employment increased from 15 to 22 percent during the 15-year period.

- Nearly four times as many doctorate recipients in physics, chemistry, and the biological sciences had secured postdoctoral study appointments than had found academic positions immediately following the Ph.D., reflecting the prevalence in those fields of the postdoctoral appointment as the first step on the ladder to a faculty position.
- Engineering Ph.D.s find employment in business and industry in larger proportions than in any other field, with 30 percent of the 1983 doctorate recipients securing jobs in that sector.
- Despite a continuing tight academic job market for humanities doctorates—as evidenced by the 34 percent still seeking employment at time of doctorate—less than 10 percent of the 1983 Ph.D. recipients in the humanities had secured employment in non-academic sectors.

Postgraduation Plans of 1983 Doctorate Recipients Entering the U.S. Labor Force by Field of Study

	All Fields	Phys & Astron	Chem	Math	Engrg	Bio & Mith Sci	Ag Sci	Soc Sci	Humanities	Prof Fields	Educ
Total Ph.D.s	28,716	922	1,648	619	2,391	4,075	889	5,716	3,292	1,581	6,739
Seeking Appointment	27.1*	29.0	22.5	22.3	27.6	23.4	33.9	30.4	34.4	16.4	26.1
Postdoctoral Study	5.4	12.7	10.6	5.0	6.5	11.7	8.4	4.5	2.9	.6	1.5
Employment	21.6	16.3	12.0	17.3	21.1	11.7	25.4	25.9	31.5	15.8	24.5
Definite Plans	66.2	65.6	71.8	68.8	63.2	71.3	58.2	60.2	57.4	76.2	68.5
Postdoctoral Study	13.8	34.3	31.1	13.2	8.3	47.5	9.4	8.8	2.1	1.5	1.5
Employment	52.4	31.3	40.7	55.6	55.0	23.8	48.7	53.4	55.3	74.7	67.0
Academe	31.9	9.2	5.8	43.3	18.4	12.9	25.4	28.1	45.9	54.2	49.9
Business/Industry	10.5	15.7	31.4	7.6	29.6	5.3	15.0	8.7	3.5	7.8	4.9
Government	5.5	6.1	2.5	3.2	5.9	3.8	6.9	8.1	1.8	4.7	6.7
Nonprofit	3.6	.3	.7	.8	.8	1.4	.8	7.5	3.3	7.6	4.7
No Report	.7	.0	.2	.6	.3	.3	.7	1.0	.9	.4	1.3
Plans Not Reported	6.7	5.4	5.7	8.9	9.2	5.3	8.0	7.4	8.3	7.3	5.4

*Vertical percentage based on doctorates in each field entering the U.S. labor force.

NOTE: Details may not add to totals because of rounding.

SOURCE: National Research Council, Office of Scientific and Engineering Personnel, Doctorate Records File.

Office of Scientific and
Engineering Personnel
National Research Council
2101 Constitution Ave., N.W.
Washington, D.C. 20418

Non-Profit Organization
U.S. Postage
PAID
Washington, D.C.
Permit No. 7750

Engineering College Research & Graduate Study

Foreword

C. A. Coberly
Chairman, ASEE Engineering
Research Council

One of the services performed by the Engineering Research Council (ERC) for the members of ASEE is to assist with publishing the Engineering College Research and Graduate Study issue of *Engineering Education*. This issue marks the eighteenth year that data from colleges of engineering have been collected and published. Through the years, committees of ERC have considered suggestions from the members for changes in the questionnaire and have adjusted the form of the report until it seems to meet the needs of most schools. In recent years major changes in questions and format have been kept to a minimum to allow year-to-year comparisons to be made and simplify data collection by the colleges.

This year 218 institutions responded to ERC's survey and submitted data, all in camera-ready form. The data have many uses. The issue is a convenient source of general information about the institutions. It can be used to compare

schools with regard to faculty size, enrollment, degrees granted, research expenditures and other factors. Such data can be useful in preparing budgets and in general evaluation of programs.

The 1982-83 responses continue to show the importance of engineering colleges as a national resource for research. The volume of sponsored research reported again totals more than a billion dollars. This is a tribute to the faculty of schools that planned the programs and prepared the proposals. Research has become an essential, integral part of our higher education system; in engineering it is largely funded in response to faculty efforts.

The issue can be a valuable reference for use by prospective graduate students. Senior advisers and placement officers may wish to make it available for wide use.

The general information provided by the schools can also be useful in helping those who administer research to establish and maintain contact with their counterparts in other institutions. ASEE's Engineering Research Council representative at each school is listed. If you have a problem or a question, look up a name and phone number, and call someone who may have faced the same situation before.

The issue also features an article by Jason M. Salsbury, president of Saljas Management and Consulting,

Inc., on a timely topic, "Entrepreneurship, or Seeking Industry Sponsorship of University Research." This article can be of real value to those approaching an industry for research support for the first time and also for those who want to compare their approaches to those the author recommends. He makes some important points about the need for freedom to publish the results of research work in the open literature. Principal investigators, as well as college research administrators, should scrutinize all funding agreements and contracts carefully to make certain that final control of publication rests with the research investigator. Of course, safeguards against inadvertent release of proprietary information and untimely publication of patentable discoveries may require some publication delays. The article gives advice in many areas based on the author's successful experience.

The Engineering Research Council's board appreciates the cooperation of the participating institutions, the fine efforts of the ASEE editorial staff and all the others who have contributed to this issue. If you have suggestions or comments, the ERC Publications Committee would be pleased to receive them.

C.A. Coberly is associate dean of engineering and a professor of chemical engineering at the University of Wisconsin-Madison.

UNIVERSITIES OFFERING PH.D. PROGRAMS IN INDUSTRIAL ENGINEERING

School	Faculty Size	Ph.D. Enrollment Fall 1983	Ph.D. Degrees 1982-83	Areas of Ph.D. Research 1982-83
1) Alabama - Huntsville	5	7	1	Operation Research
2) Arizona State	18	21	3	Computer Aided Systems, Integrated Systems, Manpower Schedules
3) Arizona	12	10	5	Production, QC, Math Prog., Nonlinear Syst., Image Proc.
4) Arkansas	15	4	0	O.R., Robotics
5) Auburn	26	11	0	Ergonomics Safety, Simulation
6) Cal. Berkeley	14	41	8	O.R.
7) Central Florida	14	15	0	-
8) Clemson	4	5	0	O.R.
9) Columbia	12	20	3	Industrial Economics, Reliability
10) Cornell	19	44	5	Applied Prob. Inventory Control, Math. Prog. Optim.
11) Florida	16	13	3	Manuf. Systems, Network Location, Traffic Assignment
12) George Wash.	18	80	5	Eng. Administration, O.R.
13) Georgia Tech	39	45	9	O.R., Production, Prob. Stat, Mat. Hdq.
14) Houston	10	4	0	O.R., Estimation Theory, Computer Languages
15) Illinois	N/A	-	0	O.R., Production
16) Iowa State	26	10	1	Optimization, Inventory, Human Factors, Management
17) Iowa	7	9	1	Simulation
18) Kansas State	11	6	0	Human Factors, Manufacturing
19) Lehigh	11	7	2	Statistics, Facility Location
20) La. Tech	6	4	0	-
21) Mass	13	32	1	Prod. Planning, Optim., Human Factors
22) Michigan	18	39	4	O.R.
23) Minnesota	?	2	0	-
24) Miss. State	7	1	0	-

UNIVERSITIES OFFERING PH.D. PROGRAMS IN INDUSTRIAL ENGINEERING (CONT'D.)

School	Faculty Size	Ph.D. Enrollment Fall 1983	Ph.D. Degrees 1982-83	Areas of Ph.D. Research 1982-83
25) Missouri	9	4	2	Risk Management
26) Missouri-Rolla	11	9	0	Engineering Management
27) Nebraska	8	16	1	Operations Research
28) SUNY	7	33	3	Job Performance, Integer Prog.
29) N.C. State	20	41	6	Stochastic Models, Lot Sizing, Optimal Replacement
30) Northwestern	14	33	7	Operations Research
31) Ohio State	16	47	4	Manufacturing, Statistics, O.R.
32) Oklahoma State	12	19	3	Statistics, O.R., Management
33) Oklahoma	8	14	0	-
34) Oregon State	8	5	3	Productivity, Statistics
35) Penn State	16	18	7	Operations Research
36) Pitt	10	16	2	Operations Research in Health Systems
37) Poly. Inst. of N.Y.	12	15	3	Operations Research
38) Purdue	22	52	10	Manuf., O.R., Production, Human Factors
39) Rutgers	7	1	0	-
40) South Florida	8	7	0	-
41) Southern Cal.	9	11	3	Simulation, Q.C., Human Factors
42) SMU	12	15	0	-
43) Stanford	9	9	1	-
44) Syracuse	7	9	0	-
45) Texas A&M	20	54	6	Human Factors, Simulation, Systems Analysis, Reliability
46) Texas Tech	10	16	3	O.R., Ergonomics
47) Texas-Arlington	8	12	1	Injury Study
48) VPI	25	48	10	Human Factors, Manuf., O.R.

ASEE Survey of Engineering Faculty and Graduate Students, Fall 1983

The faculty shortage worsened at public schools,
but higher salaries and better working environments
improved faculty recruitment and retention.

Paul Doigan
Chairman, Engineering
College Faculty Shortage
Survey Committee

The questionnaire of the fall 1983 survey of engineering faculty and graduate students retained most of the questions from earlier surveys (see box) but was expanded to obtain additional information on graduate study and projections of anticipated graduates. This and the previous surveys sought, in particular, to assess the impact of faculty shortages on the quality of engineering education, determine what faculty are needed to maintain or restore quality to engineering programs, track the increase or decrease of U.S. graduate students, and identify trends in faculty recruitment and retention.

Faculty Shortages

That serious faculty shortages persist in U.S. engineering schools is confirmed by the 1983 survey. The 186 engineering schools that responded reported that 8.5 percent

(1,234) of their authorized full-time faculty positions were unfilled in fall 1983, compared with 7.9 percent in fall 1982. Extended to all engineering schools, the 8.5 percent shortage would total approximately 1,570 unfilled full-time faculty positions.

The 186 engineering schools responding included over 70 percent of the public and over 50 percent of the private engineering schools. They represent nearly 80 percent of the

total graduate and undergraduate enrollments in U.S. schools awarding baccalaureate or higher degrees in engineering. There were 14,550 authorized full-time faculty positions reported by these schools. Using both full-time graduate and undergraduate enrollments as the basis for extrapolation, the total number of authorized full-time faculty positions in all engineering schools is estimated to be 18,440. The distribution

About the Study

The fourth in a series of surveys on engineering faculty and graduate students was conducted in fall 1983 by the Engineering College Faculty Shortage Survey Committee of ASEE's Quality of Engineering Education project. Previous surveys were conducted by the Engineering Manpower Commission for the ASEE faculty shortage project in 1981 and 1982, and by the American Council on Education's Higher Education Panel in 1980. The 1981 findings were published in the November 1982 *Engineering Education*, the 1982 findings in the October 1983 issue.

Of the 279 questionnaires mailed in fall 1983 to deans at schools offering bachelor's or higher degrees in engineering, 186 were returned and usable (67%). ABET accreditation was not required for participation in the survey.

Members of the Engineering College Faculty Shortage Committee are: Paul Doigan (chairman), Morris Cobern, National Science Foundation, George E. Dieter, University of Maryland, and Robert H. Page, Texas A&M University. The committee appreciates the prompt response by the engineering deans and others who completed the questionnaires.

The survey was conducted with a National Science Foundation grant (SRS-8319227) and represents conditions reported in fall 1983.

Net Flow of Personnel Is From Industry/Government to Academe

► The number of engineers moving to academe from industry/government in 1983-84 exceeded the loss of faculty to those sectors by more than 60 percent.

of authorized full-time faculty positions and vacancies based on these enrollments are shown by discipline in table 1.

The distribution of authorized full-time engineering faculty positions reported by these schools in 1983 was not very different from that reported a year earlier; the percentage of electrical and mechanical engineering positions rose slightly.

The percentage of unfilled positions reported by public institutions increased from 8.4 percent in 1982 to 9.5 percent in 1983, while vacancies reported by private schools decreased from 6.6 percent in 1982 to 5.4 percent (table 2). With the exception of civil engineering, public schools indicated a larger percentage of unfilled positions for each of the disciplines reported. Private schools indicated fewer unfilled positions in each of the reported disciplines.

→ The highest percentage of unfilled positions remains at the assistant professor level at all schools, although slightly less (20%) than reported in 1982. Private schools, however, reported a much lower percentage of unfilled positions at both the assistant professor and instructor levels. Tables 3 and 4 give the distribution by rank for both public and private schools and a comparison with unfilled positions one year earlier.

Table 1. Estimated Distribution of Authorized Full-time Engineering Faculty Positions and Vacancies, Fall 1983.*

Engineering Field	All Schools	
	Authorized	Vacancies
Aeronautical & Astronautical	680	50
Chemical	1330	90
Civil	2950	150
Computer Science & Computer Engineering	1490	240
Electrical	4040	390
Industrial	990	100
Mechanical	3550	270
All other	3440	280
Total	18,440	1,570

* Extrapolated from survey data on the basis of nationwide enrollment figures.

Table 2. Unfilled Positions As Percentage of Authorized Full-time Positions, Fall 1983.

Engineering Field	Public School		Private School		All Schools	
	%	(1982)	%	(1982)	%	(1982)
Aero & Astronautical	8.9%	(6.6)	2.7%	(3.2)	7.7%	(5.8)
Chemical	8.0	(6.5)	4.9	(5.1)	7.1	(6.0)
Civil	5.6	(6.0)	3.6	(5.8)	5.2	(6.0)
Computer Sci./Engrg.	19.2	(17.9)	8.3	(14.7)	15.8	(16.8)
Electrical	11.0	(8.3)	6.0	(6.3)	9.7	(7.7)
Industrial	11.5	(9.2)	5.3	(8.9)	10.4	(9.1)
Mechanical	8.6	(8.4)	4.7	(6.5)	7.7	(7.8)
All Other	8.8	(8.3)	6.3	(4.9)	8.2	(7.4)
All Fields	9.5%	(8.4)	5.4%	(6.6)	8.5%	(7.9)

() 1982 survey results

Table 3. Unfilled Engineering Faculty Positions by Rank, Fall 1983.

Rank	Public School		Private School		All Schools	
	%	(1982)	%	(1982)	%	(1982)
Professor	4.0%	(3.1)	2.5%	(2.4)	3.6%	(2.9)
Associate Professor	7.3	(5.3)	4.2	(3.5)	6.5	(4.8)
Assistant Professor	22.1	(22.1)	13.1	(17.7)	20.0	(20.8)
Instructor	8.1	(5.7)	2.6	(8.7)	6.9	(6.3)
All Ranks	9.5%	(8.4)	5.4	(6.6)	8.5	(7.9)

() 1982 survey results

Table 4. Percentage of Fall 1983 Engineering Faculty Positions Remaining Unfilled Since Fall 1982.

Rank	Public School		Private School		All Schools	
	%	(1982)	%	(1982)	%	(1982)
Professor	42.8%	(48.4)	51.2%	(35.0)	44.3%	(45.1)
Associate Professor	49.2	(62.3)	20.6	(39.3)	45.0	(57.8)
Assistant Professor	52.9	(60.2)	42.0	(51.0)	51.2	(57.8)
Instructor	34.8	(69.6)	0	(22.2)	32.0	(56.2)
All Ranks	49.5%	(59.9)	39.4	(45.5)	47.9	(56.6)

() 1982 survey results

Shortage Persists at Public Schools and at Entry Levels

- The worsening of the faculty shortage—from 7.9 to 8.5 percent of authorized positions unfilled—has occurred largely at public institutions.
- Private schools show overall improvement but reported heavier teaching loads.
- Most new faculty members are hired at associate or full professor ranks, not at entry level where shortage is most severe.

Table 5. Change in Ability to Recruit and Retain Faculty, Fall 1983.

Degree of Change	Public School		Private School		All Schools	
Substantial Increase	3.4%	(3.0)	1.8%	(10.3)	2.8%	(5.7)
Slight/Moderate Increase	32.8	(22.2)	33.3	(34.5)	33.0	(26.8)
No Change	34.4	(15.2)	43.8	(13.8)	37.5	(14.7)
Slight/Moderate Decrease	29.4	(28.3)	21.1	(25.9)	26.7	(27.4)
Substantial Decrease	0	(31.3)	0	(15.5)	0	(25.4)
Total	100%	(100)	100%	(100)	100%	(100)

() 1982 survey results

Table 6. Effect of Inability To Recruit and Retain Faculty, Fall 1983.

Effect	Public School		Private School		All Schools	
Reduction in Research	28.6%	(47.6)	16.7%	(29.6)	25.5%	(42.2)
Increased Teaching Loads	77.1	(80.9)	75.0	(63.0)	76.6	(75.6)
Greater Reliance on Teaching Ass'ts. and/or Part-time Faculty	97.1	(80.9)	58.3	(55.6)	87.2	(73.3)
Course Not Offered	45.7	(58.7)	41.7	(44.4)	44.7	(54.4)
No Significant Effect	2.9	(6.3)	25.0	(3.7)	8.5	(5.6)

() 1982 survey results

Table 7. Factors to Which Improvement in Ability to Recruit and Retain Faculty Were Attributed, Fall 1983.

	Public Schools	Private Schools	All Schools
More Attractive Salaries from Regular University Resources	67.4%	85.0%	73.0%
Industry-Sponsored Programs for Enhancing Salaries	25.6	30.0	27.0
State Government Activities to Improve Funding for Engineering	20.9	5.0	15.9
Improved Faculty Environment Other than Salary	39.5	35.0	38.1
Other	23.3	25.0	23.8

The Real Engineering Faculty Shortage

► If based on the number of positions needed to "maintain or restore quality," the faculty shortage soars to 23 percent.

Some Improvements

► Both public and private schools reported more success in recruiting and retaining faculty.

► The percentage of unfilled faculty positions remaining vacant since the previous fall dropped from 56.6 to 47.9 percent.

Faculty Recruitment

The 1983 survey found continued improvement in recruiting and retention of engineering faculty: 35.8 percent of the schools indicated a slight, moderate or substantial increase in their ability to recruit faculty, up from 32.5 percent in 1982. As shown in table 5, public schools are still experiencing more difficulty recruiting faculty than are private schools: 29.4 percent of the public schools reported a slight or moderate decrease in their ability to hire faculty, compared to 21.1 percent of private schools.

Of the 26.7 percent of schools, public and private, that experienced a decrease in their ability to recruit and retain faculty, 25.5 percent reported a resulting reduction in faculty research, compared with 47.6 percent reporting that result in 1982. In 1983, 76.6 percent reported heavier teaching loads, about the

same as in 1982; 87.3 percent reported a greater reliance on graduate teaching assistants and temporary faculty, up from 1982; and 44.7 percent reported that they were unable to offer certain courses for lack of qualified faculty members, a decrease from 1982. A larger percentage of both public and private institutions reported more reliance on teaching assistants and part-time faculty than in 1982, but only private schools reported heavier teaching loads. Both public and private schools reported less difficulty in offering specific courses than in 1982. The effects of the inability to recruit and retain faculty are summarized in table 6.

More than 73 percent of the schools attributed their improved ability to recruit and retain faculty to the more attractive salaries available from regular university resources; 85 percent of the private schools and 67.4 percent of the public schools cited this factor. A better environment for faculty, other than salary, was reported as the second most important factor by 38 percent of the respondents. Cited as contributing to a better environment were lower teaching loads, better research and laboratory equipment, renovated and expanded facilities, seed money for research, an exceptionally good accreditation visit, and faculty development leaves.

Nearly 24 percent of the schools reported other reasons for their success in recruiting and retaining faculty, including more creative and vigorous faculty recruiting, "more good Ph.D.'s available," improvement in their school's image, the tightening of the industrial job market, controlled enrollments and improvement in their reputation for research. The distribution of responses on the ability to recruit and retain faculty is summarized in table 7.

Faculty Mobility

The 150 schools that responded to the survey question on faculty mobility reported that 300, or approximately 2.1 percent of their full-time faculty, left their institutions to ac-

Table 14. Size of Sections in Junior/Senior Classes, Fall 1983.

	Public Schools	Private Schools	All Schools
Substantial Decrease	0.8%	1.7%	1.1%
Slight Decrease	11.8	11.7	11.7
No Change	37.0	35.0	36.3
Slight Increase	37.8	45.0	40.2
Substantial Increase	12.6	6.7	10.6

the engineering deans responding to a question on the quality of engineering education expressed concern and noted that student/faculty ratios were increasing. The average enrollment in a typical junior or senior class was reported in 1982 to have increased up to 56 percent since 1977. Following up on this question, the current survey found that more than 10 percent of the responding schools had experienced a substantial increase in the size of sections in junior and senior classes (table 14). More public than private schools reported this condition. A slight or substantial increase in class size was reported by more than half of the responding schools, while less than 13 percent reported a slight or substantial decrease in class size.

The Real Faculty Shortage

When the need for engineering faculty was questioned in terms of the number required "to maintain or restore quality in your programs," engineering deans reported that their authorized full-time faculty strength is less than 85 percent of the number required (table 15). This translates into nearly 22,000 full-time faculty needed in the nation's engineering schools, and a "real" faculty shortage of over 23 percent rather than the 8.5 percent shortfall reported on currently authorized positions.

This is the second year that data

Table 15. Authorized Faculty Positions As Percent of Number Needed to Maintain or Restore Quality, Fall 1983.

	Public Schools	Private Schools	All Schools
Professor	92%	100%	94%
Associate Professor	82	95	85
Assistant Professor	63	83	67
Instructor	83	98	86
All Ranks	80%	95%	84%

Table 16. Faculty Shortage Based on Need to Maintain or Restore Quality, Fall 1983.

	Public Schools	Private Schools	All Schools
Professor	10.7%	0.6%	8.5%
Associate Professor	23.3	8.6	20.3
Assistant Professor	50.2	27.8	45.8
Instructor	22.9	4.5	19.5
All Ranks	26.7%	10.1%	23.2%

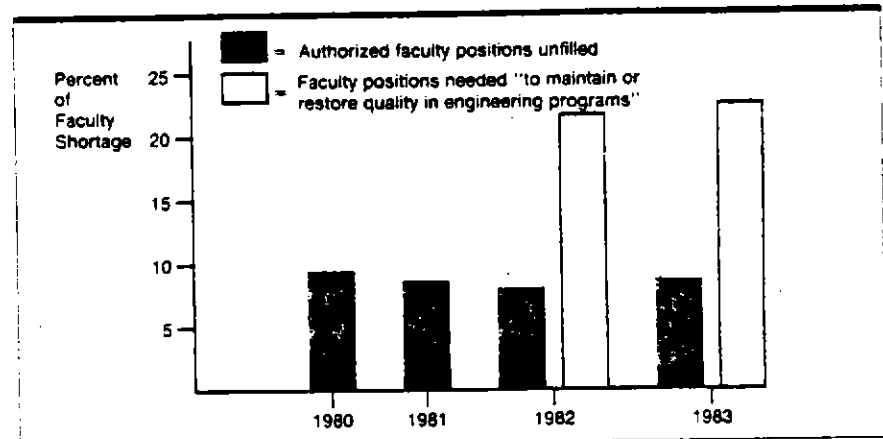


Figure 2. Faculty shortages.

on faculty needed to maintain or restore quality have been collected. The two-year trend, along with four years of data on authorized positions, is shown in figure 2. Further evidence of the plight of the public schools is revealed in table 16: Public schools report a "real" faculty shortage of nearly 27 percent, compared to slightly more than 10 percent at private schools.

Paul Doigan, chairman of the ASEE Engineering College Faculty Shortage Survey Committee, recently retired from the General Electric Company after 34 years. He has long been active in ASEE, serving as chairman of the College-Industry Council and the Relations With Industry Division and as a member of the Board of Directors. The immediate past-chairman of the Engineering Manpower Commission, he is engaged in consulting on education, manpower and immigration problems.

Table 12. Percentage of U.S. Students Among First-Time, Full-Time Graduate Students.

Engineering Field	M.S. Track			Ph.D. Track			All Students		
	1981	1982	1983	1981	1982	1983	1981	1982	1983
Aero & Astro	67.7%	73.2%	72.9%	51.5%	54.1%	50.8%	63.2%	67.0%	67.2%
Chemical	58.6	63.2	67.6	54.4	53.6	66.8	57.4	60.1	67.4
Civil	55.2	57.0	59.1	44.6	44.4	49.4	53.2	54.6	57.5
Computer Sci./Engrg.	63.0	81.1	57.3	68.2	65.3	64.3	62.2	61.9	58.3
Electrical	62.8	61.8	65.4	48.7	49.6	49.6	59.4	59.1	62.4
Industrial	56.3	57.1	64.5	45.6	48.9	42.0	54.0	55.1	61.2
Mechanical	61.8	60.1	66.0	43.2	42.5	41.8	58.8	56.7	61.6
All Fields	60.1	61.6	64.1	48.5	52.0	52.0	57.6	59.4	61.8

Table 13. Graduate Student Stipends,* Fall 1983.

	Public Schools		Private Schools		All Schools	
	High	Average	High	Average	High	Average
A-Teaching Assistants						
First Year	\$6,833	\$5,523	\$5,074	\$4,642	\$6,448	\$5,319
Second Year	7,348	6,040	5,122	4,786	6,846	5,750
Third Year and Beyond	8,236	6,640	5,838	5,350	7,561	6,325
B-Research Assistants						
First Year	\$7,837	\$5,694	\$5,783	\$5,209	\$7,247	\$5,576
Second Year	7,670	6,309	6,250	5,359	7,349	6,087
Third Year and Beyond	9,052	6,564	6,831	5,660	8,510	6,353

*Net for 20 hours/week during academic year, excluding tuition and fees paid by student.

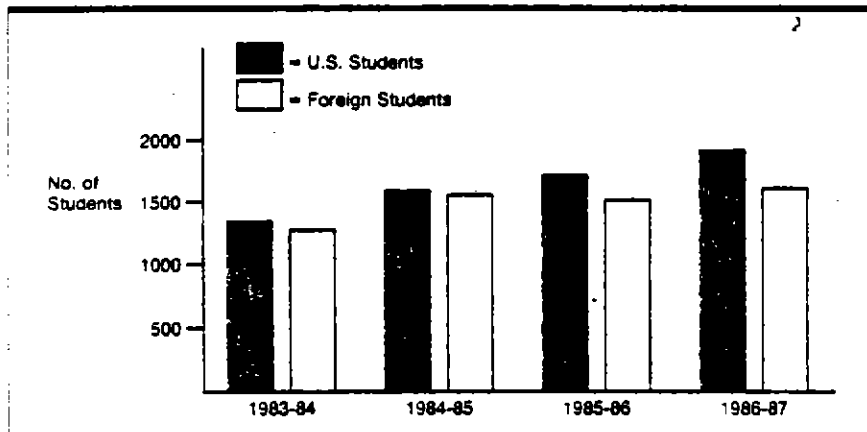


Figure 1. Projections of engineering Ph.D. graduates.

Graduate Student Trends

- ▶ Full-time enrollment of U.S. graduate students has risen for the past three years.
- ▶ The percentage of Ph.D.-track students who were U.S. citizens remained the same as in 1982.
- ▶ The percentage of research assistantships held by U.S. students increased over 1982, but the percentage of U.S. teaching assistantships and fellowship holders fell.
- ▶ The percentage of U.S. citizens enrolled in computer science/engineering dropped for the third year.

At the master's level, increases in first-time full-time enrollments of U.S. students were reported in chemical, civil, electrical, industrial and mechanical engineering (table 12). For the third year, computer science/computer engineering recorded decreases in the percentage of first-time U.S. students enrolled. At the doctoral level, increases in first-time full-time enrollment were reported only in chemical and civil engineering.

The survey included a new question on the anticipated increase in the number of Ph.D. graduates over the next three years. Extrapolating these projections based on graduate enrollment to the total engineering school population, it is estimated that the number of Ph.D. graduates will increase to over 3,600 by 1987 (figure 1). The percentage of U.S. graduates is expected to account for over 54 percent of the total.

As reported earlier, limits on the size of graduate stipends were cited as being a serious obstacle to increasing the number of Ph.D. graduates. At private institutions, where tuition and fees are higher, the average net stipends paid to both teaching and research assistants were lower than at public institutions. The average of the high figures (\$7,472 vs. \$5,278) shows an even greater spread between the public and private schools. A look at the current net stipends (excluding tuition and fees paid by the student) as reported by 150 of the schools that offer graduate programs is given in table 13.

Quality of Engineering Education

Last year, more than 85 percent of

Table 8. Faculty Mobility, 1982-83 Academic Year.

	Public Schools	Private Schools	All Schools
Voluntarily Left for Industry/Government	254	46	300
Joined Faculty from Industry/Government	414	83	497
Tenured Positions	(308)	(75)	(383)
Non-Tenured Positions	(106)	(8)	(114)

cept employment in industry or government—a proportion higher at public than at private schools (table 8). These schools reported that 497 individuals left full-time positions in industry or government to join their engineering faculties. The net flow from industry and government into the universities is more pronounced than in the two previous surveys.

The attractiveness of industry and government salaries and working conditions may be a major obstacle to attracting and retaining faculty at the entry level but apparently not at higher academic ranks. More than 62 percent of the faculty positions filled by new entrants from industry or government were at the professor or associate professor rank, while only 26 percent were at the assistant professor level. Movement of faculty members to more attractive positions at other engineering schools may be a major factor in faculty retention for individual schools.

More than 77 percent of the individuals coming to the universities from industry or government entered tenured positions; almost 74 percent of these were at the rank of associate professor or professor (table 9). At public institutions, over 74 percent of these people entered tenured positions, compared with over 90 percent at private institutions.

With the exception of industrial engineering, a net gain of faculty to the engineering schools was experienced in all disciplines for which data were collected. Electrical engineering experienced the greatest influx of faculty members, a net gain more than two-and-a-half times the loss.

Production of Ph.D. Graduates

Asked about what factors would

limit Ph.D. production over the next five years, respondents most frequently cited insufficient numbers of qualified applicants, insufficient funding for graduate student support, and limitations on graduate stipends (table 10). Nearly 72 percent of the schools ranked insufficient funding as the most or second most important factor. The only major difference between responses from public and private schools was on the size of graduate stipends: fewer private schools reported that as a major factor limiting Ph.D. production.

Graduate Student Characteristics

The 150 schools that submitted data on full-time graduate students reported that their fall 1983 graduate enrollment was composed of 61.9 percent U.S. students and 38.1 percent foreign national students. U.S. students accounted for 77 percent of the fellowship holders, 56.6 percent

of the teaching assistantships and 57.3 percent of the research assistantships (table 11). The percentage of the research assistantships held by U.S. students increased over 1982, but the percentage of teaching assistantships and fellowship holders fell.

Public institutions were primarily responsible for the increase in total U.S. graduate student enrollment from 57.4 percent in 1982 to 61.9 percent. The survey found that each of the reported disciplines showed an increase in U.S. graduate students, with the largest in electrical (62.8 vs. 56.9 percent the previous year) and industrial (61.0 vs. 53.1 percent) engineering.

First-time enrollment of U.S. graduate students increased from 59.4 percent in 1982 to 61.8 percent in 1983. The percentage of Ph.D.-track students (52%) remained the same as in 1982, while M.S.-track students were reported to have increased from 61.6 to 64.1 percent.

Table 9. Tenure Status of Faculty Coming from Industry or Government, 1982-83.

	Tenured Position	Non-Tenured Position	Total
Professor	163 (42.6%)	7 (6.1%)	170 (34.2%)
Associate Professor	119 (31.1)	19 (16.7)	138 (27.8)
Assistant Professor	95 (24.8)	33 (28.9)	128 (25.8)
Instructor	6 (1.6)	55 (48.2)	61 (12.3)
Total	383 (100%)	114 (100%)	497 (100%)

Table 10. Factors* Limiting Ph.D. Production, Fall 1983.

	Public Schools	Private Schools	All Schools
Insufficient Funding for Graduate School Support	71.8%	71.9%	71.8%
Insufficient Number of Qualified Candidates	48.2	53.1	49.6
Limitations on Size of Graduate Stipends	51.8	37.5	47.9
Insufficient Facilities and Space	18.8	21.8	19.7
Insufficient Qualified Faculty	7.1	9.4	7.7
Other	3.5	3.1	3.4

*Ranked either first or second in importance.

Table 11. Percentage of U.S. Students in Graduate Student Population, Fall 1983.

	Public Schools	Private Schools	Total Schools
Teaching Assistants	57.2% (56.5)	53.5% (59.4)	56.5% (57.1)
Research Assistants	57.3 (53.4)	57.2 (58.1)	57.3 (54.8)
Fellowships	82.1 (85.7)	68.9 (72.4)	77.0 (80.2)
Other	64.5 (52.7)	57.5 (49.9)	63.5 (51.8)
All Students	62.8 (57.2)	58.4 (58.0)	61.9 (57.4)

() 1982 survey results

C
 H
 R
 O
 N
 I
 C
 L
 E
 N
 O
 V
 E
 M
 B
 E
 R
 7
 1
 9
 8
 4
 N
 O
 R
 T
 H
 E
 A
 S
 T
 E
 R
 N
 C
 O
 L
 L
 E
 G
 I
 A
 N
 S
 I
 N
 S
 T
 I
 T
 U
 T
 I
 O
 N
 A
 L
 A
 S
 S
 O
 C
 I
 A
 T
 I
 O
 N
 O
 F
 H
 I
 G
 H
 E
 R
 E
 D
 U
 C
 A
 T
 I
 O
 N

D. Lee

NOV 07 1984
N. C. EVANGELAUF

THE CHRONICLE

of Higher Education.

November
Volume 3

US Summary

as on inside pages
ent at the country's two-
s is declining at a higher
more than 20 years.

from the Defense De-
or research on Africa
ten the field, according to
f the African Studies As-
Story on Page 7.

s will not have to verify
gistration status of stu-
receive federal aid next
on Page 23.

ath last
Prime
India
ft India
s most
l cam-
r edu-
d sci-
ry on



WIDE WORLD

e professors are appear-
nd more frequently as ex-
entators in the national
media. Story on Page 25.

at Bowdoin College
the quantity of chemi-
the size of equipment that
us chemistry experi-
ory ... Page 25.

ests that many universities
tuted for their athletes are
to come under legal scruti-
on Page 31.

ecutive board of UNESCO

'FOUNDING OUR INSTITUTIONS ANEW'

Colleges Must Hire 500,000 Professors in the Next 25 Years, New Study Finds

By JEAN EVANGELAUF
SAN FRANCISCO

American colleges and universities will need to hire about 500,000 faculty members in the next 25 years, thereby replacing virtually the entire professoriate, according to Howard R. Bowen, professor of eco-

nomics and education at Claremont Gradu-
ate School.

"We will be founding our institutions anew," he said.

Speaking last week at a meeting of edu-
cation researchers, he called this turnover
of professors "the most important issue
before higher education today."

Mr. Bowen, along with Jack H. Schu-
ster, professor of education and public poli-
cy at Claremont Graduate School, com-
mented on some early results of a two-year
study of the professoriate that they have
conducted. Mr. Bowen gave his opinion of
the implications of their labor-market and
demographic research, and Mr. Schuster
spoke of his observations, based on visits
to 38 campuses, of a professoriate that he
said is alienated and isolated.

Even though hiring will drop in the near
future, "there will not be a single year in
the next 10 without substantial faculty
recruitment," Mr. Bowen said.

The great surge in recruitment is at least
a decade away, but now is the time to think
about the faculties of the future, Mr. Bow-
en said. Because the average time between
Continued on Page 29, Column 1

Judge Clears Way for NCAA to Play Role in TV Pacts

OKLAHOMA CITY

The federal judge who two years ago
struck down the National Collegiate Ath-
letic Association's contracts for televising
college football last week cleared the way
for the association to have a role in negoti-
ating television arrangements in the future.

The decision also affirmed the associa-
tion's right to prohibit television appear-
ances by college teams that have violated
its rules.

U. S. District Court Judge Juan G. Bur-
ciaga modified the 1982 opinion in which
he ruled that the N.C.A.A.'s demand for
exclusive power to regulate the televising
of college football violated federal antitrust
law.

"I did not seek to prohibit the N.C.A.A.
from openly and competitively participat-
ing in the college television market," he
said.

"What the court does prohibit is the ille-
gal activity pursued by the N.C.A.A. and
Continued on Page 34, Column 1

Many Cou Stressing in Univers

Trend toward g
to education see

By MALCOLM C

Faced with financial p
academic standards, and
competition in high tech
ropean and North Am
have started to empha
quantity in their system
tion.

As a result, their co
creased access to their co
sities over the past 25 y
weakening.

No educational leader
ficial has publicly emb

Minorities' access to
by the new emphasis
sions directors warn.

"elitism" or renoun
principle of increased
term goal, but many h
cus to providing the b
tion for their brightest

"There is a clear tr
cess is no longer the hig
Frank Newman, a fello
Foundation for the
Teaching who is prepa
ture government polic
ucation in the United S

The most direct stat
in emphasis has com
Continued on

New York U. Sets \$1-Billion Goal

New York University announced
last week that it hopes to raise a bil-
lion dollars by the year 2000—a goal
fund-raising experts say is within the
reach of as many as 25 other uni-
versities, as well. Story on Page 20.

U.S. Colleges Must Hire 500,000 Professors in Next 25 Years, a New Study Finds

Continued from Page 1
the receipt of a bachelor's degree and a doctorate is 10 years, he said, those future faculty members will be entering graduate schools in the next few years.

The new faculty members, Mr. Bowen said, "should be personages, as distinct from nonentities." They should be "creative intellectuals who are alive and vigorous," he added—people who have "a sense of being called to the profession."

Among other ideal qualities are "a sound general education," "intellectual breadth and a contemplative disposition," "keen mastery of the special field and the motivation to keep up to date," and "the ability to serve as exemplars to some students," he said. New faculty members should have "superior general intelligence"

and be among "the upper 5 per cent of the population in terms of I.Q.," he said.

In addition, he said, they should have patience, the capacity to work hard without supervision, and the respect of their students.

Mr. Bowen emphasized teaching. "Writing books, jurying articles, and fundraising are add-ons," he said, not necessary qualifications for faculty positions.

Although "present faculties are probably the best equipped for the task that we've ever had," he said, "they are not the most highly motivated." Unless institutions improve working conditions and raise salaries, they cannot compete with the fields of law and business management for the best students, he said.

Speaking of the recent report by a

National Institute of Education study group on undergraduate education, of which he was a member, Mr. Bowen said that 17 of the group's 27 recommendations concerned the faculty of the future, and that "it all adds up to greater attention to teaching." Mr. Bowen called for some balance in the conflicting roles of the professoriate as "a learned profession or skilled pedagogues."

Mr. Schuster said the conflict between teaching and research had resulted in "an eclipse of the sense of community and collegiality" among faculty members and a "deepening caste system."

He said the fragmentation stemmed from two sources: a faculty that is increasingly heterogeneous and a labor market that favors buyers over sellers.

Some loss of community comes from the increasing specialization of the disciplines, a widening array of institutions, and a professoriate that is growing more diverse in terms of religion, sex, and race, Mr. Schuster said. But more serious are the changing values that accompany the changing labor supply, he added.

Colleges Now Have Their Pick

Because the current supply of doctoral faculty members exceeds demand, he said, colleges and universities can have their pick of new recipients of doctorates. As prestigious doctoral institutions graduate the graduates of better-known universities, where research is a high priority, "campus aspirations normally spiral upward," Mr. Schuster said.

There is "a veritable stampede toward research" at the newer institutions, and the "ethos of scholarship productivity" is re-emphasized the traditional research universities, he said.

Microscale Chemistry Project at Bowdoin College May Change Lab

Continued from Page 25
organic-chemistry labs by installing new ventilating systems or by updating old ones. It's expensive either way. Other colleges simply stop using certain chemicals. That helps solve the air-pollution problem, but curtails the range and type of experiments that students are able to perform.

In 1980, Bowdoin officials were set to go with a \$250,000 ventilating-system renovation, when Mr. Mayo, Samuel S. Butcher, a Bowdoin colleague; and Ronald M. Pike, a visiting professor from Merrimack College, proposed investing \$25,000 to develop a microscale lab project instead.

"Basically, we asked them to take a \$25,000 gamble," Mr. Mayo wrote in the college's alumni magazine. "If our idea worked, we felt sure that not only would Bowdoin solve its problem and save some money, but that the project would also provide a unique solution for many other schools with similar concerns."

A Way to Cut Costs

Mr. Mayo said in an interview that the project was also envisioned as a way to reduce costs, which "meant that students could perform more experiments and a larger variety" than

expected benefits that "I think are far more important." Those are primarily pedagogic.

Says Mr. Mayo, "One of our major concerns when we started was whether sophomores would be able to handle sophisticated lab techniques that for a long time had been relegated to the graduate level of organic chemistry. We were concerned that we might have to spend a lot of time introducing students to the techniques before we could get into the experiments." That would mean that significantly less subject matter could be covered.

What in fact happened was a significant improvement in the quality and what Mr. Mayo calls the "efficiency" of teaching. He and his colleagues had failed to anticipate how much the new techniques would shorten the time it takes to carry out certain operations—"that boiling off a thimbleful takes a lot less time than boiling off a quart, or cooling down, or crystallizing."

And so, in microscale, experiments that used to take an afternoon take an hour. Instead of one experiment in a single lab period, students may perform two, three, or four. A person who has difficulty with an experiment usually has time to try it again.

The additional practice enables students to acquire the necessary techniques in a shorter time than it used to take to master less sophisticated ones. "They also acquire them better," says Mr. Mayo.

Students Perform Better

That is not just the result of additional practice. Working in microscale demands a high level of concentration and dexterity and a fastidious attention to detail. "If you spill 50 milliliters of a liquid when you're working with a liter of the stuff, it's no big deal," Mr. Mayo said in his article. "But if you lose a drop of liquid when that's all you've got, you're in trouble."

Concentration, attention to detail, and repetition have proved to be a potent combination: Overall, says Mr. Mayo, "the average student performing better in the microscale lab, and we are producing a better educated product."

Mr. Mayo is not the only science educator enthusiastic about Bowdoin's project. Brown University and Merrimack and Mount Holyoke Colleges are among those also experimenting with microscale laboratories.

A major obstacle to the widespread conversion by colleges to microscale labs is the fact that conducting experiments in microscale is simply a matter of dividing everything by 100 or 1,000. Reaction times and the way substances must be manipulated can change substantially with a reduction in the amount of chemicals used. A large part of Bowdoin's project involves developing and testing the classic experiments at the smaller scale. Mr. Mayo and

MAKING MONEY FOR EDUCATION



Appendix II

Sample Letters of Interest in the Ph.D. Program in I.E.

Doc E. Davis
1000 NW 51st Street, Boca Raton, FL 33431

November 21, 1984

Dr. T. M. Khalil, Professor and Chairman
Department of Industrial Engineering
University of Miami
College of Engineering
P. O. Box 248294
Coral Gables, FL 33124

Dear Dr. Khalil:

We have recently heard that the Department of Industrial Engineering at the University of Miami is developing a PhD program. IBM supports continued development of this program.

From the perspective of IBM, the PhD program will provide utilization of a valuable resource in product development at Boca Raton. This resource, your staff and graduate students, can be helpful in the development of increased product usability by helping to plan and conduct studies related to Human Factors and Information Development (publications and training).

The following identifies how the PhD program can mutually benefit the University of Miami and IBM:

- Having a source of graduate students who can be employed as temporary interns (co-ops). These students can obtain practical work experience as a valuable adjunct to their academic course work. This arrangement also affords both students and IBM an opportunity to consider each other for a more permanent working relationship.

25J/3264/3-1

- Conducting research studies to solve usability problems related to IBM products is very important. Initially, candidate studies are conducted to support a product being developed in Boca Raton. Frequently, however, study results can be generalized to improve the usability of other IBM products.
- Awarding studies to your department can be done under the Shared University Resources (SUR) program. This program provides funding from interested IBM laboratories and corporate headquarters to conduct studies of general application to a number of products. Evaluators of study proposals strongly consider the credentials of university staff personnel. Another factor is the caliber of the graduate students who will actually be conducting the study and with whom the IBM people will be working.
- Prospective employees interested in the field of Psychology would be attracted by a local PhD program. Initially, being able to work at IBM and take graduate courses as a PhD candidate would provide an opportunity to ultimately obtain that degree. For example, there is one person in the Human Factors department who is already taking a graduate Psychology course with this goal in mind.

In view of the above facts, Dr. Khalil, we are very supportive of your plans to develop a PhD program at the University of Miami. We look forward to working with your staff and the PhD candidates who will contribute toward the increased usability of IBM products.

Regards,

Don Davis (he)

D. F. Davis, Manager
Dept. 2T4
3401
Boca Raton, FL 33432

cc: Dr. S. Asfour
University of Miami
P. O. Box 248294
Coral Gables, FL 33124

25J/3264/3-2

EARL L. WIENER
LM 239-3
NASA-AMES RESEARCH CENTER
MOFFETT FIELD, CA 94035

26 October 1984

Dr. Tarek Khalil
Department of Industrial Engineering
University of Miami
Coral Gables, FL 33124

Dear Tarek:

It was a pleasure talking with you in San Antonio, and learning of your plans for a Ph.D in the human factors area. I would be happy to help out in any way, and look forward to working with you and your faculty.

As requested, a current copy of my vita is enclosed. You asked about my current research grants. My three year grant entitled "Studies of flightdeck automation" has been extended through this academic year. I am presently writing the final report on the DC-9-80 (MD-80) automation studies. I have an additional grant, under the Intergovernmental Personnel Act, which covers a portion of my time during my sabbatical year, and will support me full time in the summer of 1985, before I return to Miami. I intend to propose continuation of the project before I return.

I hope this information is helpful.

Congratulations on your appointment as Chairman. I am sure the department will prosper.

Sincerely yours,



Earl L. Wiener,
Professor of Management Science
and Computer Information Systems

September 7, 1984

Dr. David J. Sumanth
University of Miami
Industrial Engineering Department
P.O. Box 248294
Miami, Florida 33124

Dear Dr. Sumanth:

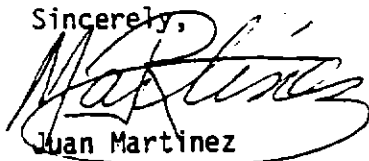
As I told you during our recent telephone conversation, I am very interested in pursuing a Doctoral Program in Industrial Engineering. Unfortunately, there are no universities that offer such a program in the South Florida area.

Since the University of Miami has an existing Industrial Engineering Department that offers both a Bachelors and Masters Program in Industrial Engineering, I feel that a Doctoral Program should not be a big problem to start.

I am certain that such a program would be very successful in a city like Miami. This is mainly due to the rapid industrial growth our city is experiencing. Furthermore, the role of the Industrial Engineer in all industries is so important, that no successful business would be able to operate without the expertise our profession provides.

If I can be of any assistance in getting a Doctoral Program at the University of Miami in Industrial Engineering started, please contact me at 596-7318.

Sincerely,



Juan Martinez

JM/fv

November 9, 1984

Dr. Asfour
University of Miami
Industrial Engineering Dept.
P.O. Box 248294
Miami, FL 33124

Dear Dr. Asfour:

In talking with Juan Martinez, I learned that a PhD program in Industrial Engineering is in the works. I would be very interested in this program. At the moment, I am working toward my Masters Degree in Management Science at the University of Miami. I am scheduled to complete the program by July 1985. After this, I would like to continue my education and have the opportunity to combine Industrial Engineering and Operations Research in a PhD program. Please keep me informed of any developments in this area.

Thank you,



Marianela Aran
Project Manager, Industrial Engineering

MA/fv



Southern Bell

Graduate Students Adviser
Industrial Engineering Department
University of Miami
Coral Gables, Fla. 33124

Oct. 2, 1984

Dear Sir/Madam :

It has come to my attention that the Industrial Engineering Department is in the process of preparing a PhD program in that field. I would like to express my interest in the program.

I have a B.S.I.E. and am on the way of attaining an M.S.I.E. . At the moment I am working full time for Southern Bell in South Florida and would like to receive any information concerning your PhD program as soon as it is available if it is not available yet. My working address is 1790 West 49th St. #403, Hialeah, Fla. 33013.

Thank you for your help in this manner.

Sincerely,

Alesia Jones-Parra Sipes



October 24, 1984

Dr. David V. Sumanth, Director
Productivity Research Group
Department of Industrial Engineering
University of Miami
P.O. Box 248294
Coral Gables, Florida 33124

Dear Dr. Sumanth:

I was pleased to know of the progress made by the College of Engineering especially in the areas of Industrial Engineering.

Please keep me posted on the progress to establish the Doctorate Program this year, as you know, I am interested in the program and would like to give it a try.

It was good to see you again,
Yours truly,


Arnold Velazquez

AV/pd

14104 S.W. 42nd Terrace
Miami, Florida 33175

July 27, 1984

Dr. David Sumanth
Dept. of Industrial Engineering
222 McArthur Building
University of Miami
Coral Gables, Fla. 33124

RE: Phd Program in Industrial Engineering

Dear Dr. Sumanth:

It was a pleasure speaking with you recently on the possibility of my pursuing a Phd program in Industrial Engineering at the University of Miami.

As you know, I have been interested in such a program for several years. In fact, I studied at the University between 1977 and 1980, and because of the lack of a relevant Phd program, I pursued instead two Masters level programs in Business and Industrial Engineering. Were it not for my fondness of the Miami area and the hope that the University of Miami would eventually offer a Phd in I.E., I would have yielded to the temptation to move to another city where such a program was available. Ironically, several of my colleagues now have their Phd's because they decided years ago that Miami simply lacked adequate educational facilities and they went elsewhere.

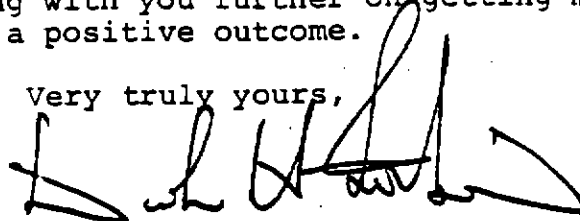
At this point in time, having recently completed my term of office as the President of the Miami Chapter of the Institute of Industrial Engineers, I am now making the pursuit of doctoral studies one of my major priorities. If a suitable program is not going to be available locally, I may have to go elsewhere and lose the many years that I have invested in the local community. For this reason, I most certainly would like to see a Phd program in I.E. materialize at the University of Miami, and I would like to be advised of the official position on this issue.

In terms of the "market" for this program in South Florida, I need not point out that the demand for Industrial Engineering skills is growing by the minute because of the emergence of the area as a new technological mecca. In addition, the need for technical skills is similarly growing in the Caribbean Basin through the new "Initiative" and in nearby Latin American countries as well.

I sincerely hope that the University administration will recognize the golden opportunity which now rests on their threshold for the institution to play a pivoted role in the development of the community through academic excellence. Unless this occurs, the institution will simply have missed the boat.

I look forward to discussing with you further on getting my studies underway and I hope for a positive outcome.

Very truly yours,

A handwritten signature in black ink, appearing to read 'L. H. Forbes', written in a cursive style.

LINCOLN H. FORBES

w: 579-5056
H: 221-5916

November 20, 1984

Dr. Asfour
University of Miami
Industrial Engineering Dept.
P.O. Box 248294
Miami, FL 33124

Dear Dr. Asfour:

After our recent conversation regarding my entrance into the Masters Program in Industrial Engineering at the University of Miami, I became interested in learning more about the PhD program in Industrial Engineering. To obtain my PhD Degree in Industrial Engineering is my long term educational objective and one that I hope to begin by July 1987. Please let me know of any developments in the PhD program. Thank you for your help.

Regards,

Ileana M. Coll

Ileana M. Coll

IMC/fv

Technical University
of Nova Scotia



P.O. Box 1000
Halifax, Nova Scotia
Canada B3J 2X4

Telephone (902) 429-8300
Telex: (TUNS) 019-21566

Department of
Industrial Engineering

November 1, 1984

Dr. Shihab Asfour
Department of Industrial Engineering
University of Miami
Coral Gables
Florida 33124

Dear Sir,

I expect to receive my M. A. Sc in Industrial Engineering from Technical University of Nova Scotia by Summer 1985. I am interested in pursuing my Ph. D in Engineering (interdisciplinary) with a major in Industrial Engineering at the University of Miami. I would appreciate if you could send me application materials and informations about the program and assistantships.

At Technical University of Nova Scotia, I have had the opportunity of performing independent research in Manual Material Handling. Specially this research is concerned with Physiological cost of work. An abstract of my present research is enclosed.

As a graduate student of IE, working in the area of Human Factors, I came to know you through your excellent publications and achievements in this area. I have enthusiastically read most of these papers. I am sure that under your supervision I can enrich my current interest and perform high quality and important research work.

It would be my great pleasure to have the opportunity of working with you.

Thank you.

Sincerely yours,

Ashraf A. Shikdar
Apt. 9-5
St. Mary's Loyola Res.
High Rise 2
Halifax, N. S.
CANADA B3H 3C3

Tel: (902) 422-4638 Res.
(902) 429-8300 Ext. 281



University of Miami
Coral Gables, Florida 33124

DEPARTMENT OF INDUSTRIAL ENGINEERING
P.O. Box 248294
School of Engineering and Architecture

(7)

May 28, 1982

Ahmad Moreb
2323 Verano Place
Irvine, California
92715

Dear Mr. Moreb:

Our Admissions Office has forwarded to us your application dated March 5, 1982 indicating your interest in pursuing a Ph.D. program in Industrial Engineering at the University of Miami.

I regret to inform you that we do not have a Ph.D. program in Industrial Engineering at the present time. However, you could apply for an Inter-departmental Ph.D. program directly through our Graduate School. If you are accepted under this program, you would prepare a plan of study at the Ph.D. level that would provide you with a great deal of flexibility since you would select courses from various departments in your area of interest.

I understand that our Admissions Office has sent you the necessary application forms and our school's catalog. Should you decide to apply for the Inter-departmental Ph.D. program, make sure you indicate so on the application form.

We appreciate very much your interest in our University and I shall look forward to meeting you personally if you decide to pursue your graduate studies at the University of Miami.

Sincerely,

David J. Sumanth, Ph.D.,
Assistant Professor and
Graduate Advisor
Industrial Engineering Department

DJS:lp

7/31/84


Department of Industrial Engineering
University of Miami
Coral Gables, Florida 33124

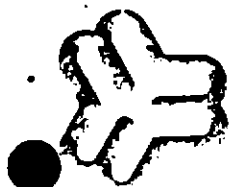
Dear Dr. Sumanth

As a graduate of the University of Miami and a practicing industrial engineer, I would like to further enhance my career with a doctoral degree in industrial engineering. My recent subjects of interest are computer-aided design and computer aided manufacturing in the footwear industry specifically and in the soft goods industry in general.

Would you kindly forward me some information on the content of the Ph.D programs offered by the Department of Industrial Engineering at the University of Miami? Looking forward to your reply,

Sincerely yours.

Filiz P. Yavuz 
P.O. Box 24-9104
Coral Gables, FL 33124



University of Miami
Coral Gables, Florida 33124

DEPARTMENT OF INDUSTRIAL ENGINEERING
P.O. Box 248294
School of Engineering and Architecture

April 12, 1982

Abdullah Ahmed Al-Haimy
University of Petroleum & Minerals
Box 561
Dhahran, Saudi Arabia

Dear Mr. Al-Haimy:

Thank you for your recent letter requesting application forms for the doctoral program in our department.

We regret that we are unable to send you any such forms as we do not presently have a Ph.D. program. We are in the process of developing one and will contact you when such an opportunity arises.

Thank you again for your interest. Should you or your colleagues be planning to obtain an M.S. degree in Industrial Engineering, please write me. I am enclosing information on the seven areas of specialization toward this degree.

We have had several students graduating from our department so far. We hope we will continue to provide the same quality education and personal attention to all our domestic and international students.

Again, thank you for your interest.

Sincerely,

David J. Sumanth, Ph.D.
Director of Graduate Studies
Industrial Engineering Department

DJS:ip

Dear Sir,

I wish to pursue my higher studies towards Ph.D. in Systems Engineering at your Graduate College. Please send me necessary forms. I will be completing my M.S. in Systems Engineering in the Summer Session of 1982 of University of Petroleum & Minerals, Dhahran, Saudi Arabia.

Hope to hear from you soon.

Sincerely,

ABDULLAH AHMED AL-HAIMY
University of Petroleum & Minerals
Box 561
Dhahran, Saudi Arabia



University of Miami
Coral Gables, Florida 33124

DEPARTMENT OF INDUSTRIAL ENGINEERING
P.O. Box 248294
School of Engineering and Architecture

July 21, 1981

H.H. Jamaluddin
A/445 Block 'C'
North Nazimabad,
Karachi - 33, Pakistan

Dear Mr. Jamaluddin:

Thank you for your recent inquiry regarding your interest in pursuing a Ph.D. program in Industrial Engineering.

We have well-established B.S.(I.E.), M.S.(I.E.), and M.S.(Env. Health) degree programs in our department. We are in the process of developing a proposal for a Ph.D. program. We anticipate having such a program 2 to 2½ years from now.

Unfortunately, therefore, we are unable to consider your request for a Ph.D. program at the present time. We appreciate, however, your having considered us as a possible place to further your academic goals. Should any of your friends be interested in pursuing an M.S.(I.E.) degree, please have them write to me directly for additional information.

Sincerely,

David J. Sumanth, Ph.D.,
Director, Graduate Studies
Department of Industrial Engineering

DJS:lp

Karachi, June 30, 1981

From: H.H. Jamaluddin
A/445 Block 'C'
North Nazimabad
Karachi - 33, Pakistan

Dear sir,

I am interested in taking up a PhD program in Industrial Engineering in the United States. I already possess a B.S.(Mech.Engg) and an M.S.(Ind.Engg) from the University of the Philippines.

Currently I am Director of Asian Productivity Consultants Ltd, a firm offering Industrial Engineering training and consultancy services.

I shall be obliged if you could kindly send me more information on your school and its graduate programs together with application forms for admission.

Thank you,

Sincerely yours

Jamaluddin, H.H.

*The Chairman
Dept of IE
University of Miami
Coral Gables
Florida - 33124*

UNIVERSITY OF CALIFORNIA, IRVINE

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO



SANTA BARBARA • SANTA CRUZ

GRADUATE SCHOOL OF MANAGEMENT

IRVINE, CALIFORNIA 92717

March 1, 1982

Chairman of the Graduate Industrial
Engineering Department
University of Miami
P.O. Box 248125
Coral Gables, Florida 33124

Dear Chairman:

I have known Mr. Ahmad A. Moreb for more than two years. He was an A student in one of my mathematical methods operations research classes. I was also on his Master of Science in Engineering thesis committee. The theme of his thesis was entitled "Use of Polygonal Functions for Adapting Fixed Charge Problems to Solutions by Linear Programming." He completed his M.S. with an average of 3.818.

He is a very mature, hardworking and highly intelligent student. I believe he has both the initiative and enthusiasm to successfully complete a Ph.D. degree in industrial engineering. He has a strong mathematical background which was demonstrated in his Master's thesis. I recommend him very highly.

Sincerely yours,

Stepan Karamardian
Associate Dean and
Professor of Mathematics

SK: gw

7
Eleanor - let's
open a
separate
file for
Ph.D. applicants
Thanks -



University of Miami
Coral Gables, Florida 33124

DEPARTMENT OF INDUSTRIAL ENGINEERING
P.O. Box 248294
School of Engineering and Architecture

July 21, 1981

Sriram Pidaparti
Hostel II/22, I.I.T.;
Powai, Bombay-400 076
INDIA

Dear Mr. Pidaparti:

Thank you for your recent inquiry regarding your interest in pursuing a Ph.D. program in Industrial Engineering.

We have well-established B.S.(I.E.), M.S.(I.E.), and M.S. (Env. Health) degree programs in our department. We are in the process of developing a proposal for a Ph.D. program. We anticipate having such a program 2 to 2½ years from now.

Unfortunately, therefore, we are unable to consider your request for a Ph.D. program at the present time. We appreciate, however, your having considered us as a possible place to further your academic goals. Should any of your friends be interested in pursuing an M.S.(I.E.) degree, please have them write to me directly for additional information.

Sincerely,

David J. Sumanth, Ph.D.,
Director, Graduate Students
Department of Industrial Engineering

CJS:lp

UNIVERSITY OF MIAMI
CORAL GABLES, FLORIDA 33124

*Approved by
T. M. Khalil*

DEPARTMENT OF INDUSTRIAL ENGINEERING
SCHOOL OF ENGINEERING AND ARCHITECTURE
P.O. BOX 248294

June 27, 1980

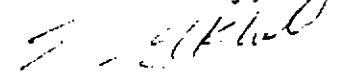
Mr. A. O. Chidi
P. O. Box 1810
Surulere
Lagos, Nigeria

Dear Mr. Chidi:

I am in receipt of your letter dated June 6, 1980, in which you express your interest in working towards the doctorate in Industrial Engineering here at the University of Miami. Unfortunately we do not currently offer the Ph.D. in Industrial Engineering. The only route a student can earn a doctorate in Industrial Engineering at the University of Miami, is through an interdisciplinary Ph.D. Program in which admission is through the Graduate School. The candidate must be very highly qualified to be accepted into this program and financial aid is very limited. Information about this program is enclosed. Meanwhile, I suggest you contact some other Universities that offer the Ph.D. such as Georgia Tech in Atlanta, the University of Florida or the University of Michigan.

We appreciate your interest in the University of Miami and will be glad to assist you in any way we can.

Yours sincerely,



T. M. Khalil
Director of Graduate Studies

TMK:e1
Enc.

June 6, 1980

The Director of Admission
Dept. of Industrial Engineering
University of Miami
Coral Gables, FL 33124
U.S.A.

Dear Sir,

Prospectus and Application Form
for post graduate Study

I would like to complete my post graduate course (doctorate) in Industrial Engineering in your institution and would be grateful if you could send me your Prospectus, formal Application Forms, Programmes and other useful information regarding requirements etc.

I am a Nigerian, aged 37, married with two children, and hold B.Sc. and M.Sc. in Engineering from recognised German Universities and would like to complete my doctorate programme in the United States.

Please channel this application to any right quarters if it is wrongly addressed to you, and oblige.

Yours sincerely

A.O. Chidi

Can you help me with this?

*Tauh
Agree here that we do not have
a PhD program. suggest that he
contact the faculty of engineering*

Appendix III

Courses Available to the Students in the Ph.D. Program
in I.E.

COURSES AVAILABLE TO THE STUDENTS IN THE Ph.D. PROGRAM IN I.E.

General Courses

MATHEMATICS

A student may select any Graduate Mathematics course subject to the approval of his/her graduate advisory committee.

Courses Pertinent to the Ergonomics/Human Factors Specialization

PSYCHOLOGY

- 509 Perception
- 604 Behavioral research design
- 605 Advanced psychological statistics I
- 606 Advanced psychological statistics II
- 608 Comparative learning
- 619 Theory of psychological measurement
- 620 Multivariate correlation methods in psychology
- 634 Stress, emotions, and motivation
- 659 Psychophysiology
- 660 Neurosciences I: neuronal mechanisms
- 661 Neurosciences II: nervous systems integration
- 663 Multivariate analysis in psychology
- 665 Data-base management systems in psychological sciences
- 666 Mathematical learning theory

MANAGEMENT SCIENCE AND COMPUTER INFORMATION SYSTEMS

- 601 Applied regression analysis
- 602 Applied multivariate statistics
- 603 Design of experiments
- 606 Nonparametric statistics
- 607 Survey sampling

PHYSICAL THERAPY

- 521 Physiology of exercise
- 525 Advanced kinesiology
- 561 Advanced tests and measurements in health, physical education, recreation, and athletics

- 621 Mechanical analysis of motor activities
- 625 Human performance cardiac rehabilitation programs
- 646 Research methods in health physical education,
recreation, and athletics

BIOMEDICAL ENGINEERING

- 501 Unified medical sciences I
- 502 Unified medical sciences II

- 511 Clinical engineering
- 575 Biomechanics
- 580 Biomedical instrumentation
- 613 Application of computers in medicine
- 617 Principles of artificial internal organs
- 623 Biocommunications I
- 624 Biomaterials

CIVIL ENGINEERING

- 508 Water and waste water engineering
- 520 Public health and environmental microbiology
- 521 Modeling environmental processes
- 645 Wastewater treatment and systems design
- 646 Water treatment and system design
- 650 Industrial waste system

ELECTRICAL AND COMPUTER ENGINEERING

- 501 Automatic control design
- 514 Microprogramming
- 517 Advanced microprocessor/microcomputer design
- 571 Applied acoustics
- 651 Microcomputer-based design
- 653 Pattern recognition
- 656 Information theory
- 663 Optimal control theory

MECHANICAL ENGINEERING

- 502 Vibrations
- 507 Advanced mechanics of solids
- 515 Automatic controls
- 520 Air pollution
- 521 Exhaust emission control
- 525 Thermal pollution
- 527 Energy technology and environment

ANATOMY AND CELL BIOLOGY

- 500 Gross anatomy
- 505 Neuroanatomy
- 634 Neurobiology of the visual system
- 643 Advanced regional anatomy-back and extremities

EPIDEMIOLOGY AND PUBLIC HEALTH

- 521 Fundamentals of epidemiology
- 541 Integrated aspects of environmental health
- 542 Chemical epidemiology
- 561 Public health nutrition
- 641 Epidemiological information systems
- 642 Environmental-occupational epidemiology

PHYSIOLOGY AND BIOPHYSICS

- 511 Neurophysiology
- 669 Nerve and synapse

RADIOLOGY

- 610 Radiological health and protection

Courses Pertinent to the Production Systems

(Production/Productivity Engineering) Specialization

PSYCHOLOGY

- 564 Psychology and personnel
- 603 Social psychology
- 611 Advanced motivation
- 634 Stress, emotions and motivation
- 665 Data-base management systems in psychological sciences

ACCOUNTING

- 500 Income tax and business decisions
- 531 international accounting and taxation
- 600 Essentials of accounting and control systems
- 602 Analysis of financial statements
- 605 Quantitative accounting analysis
- 608 Managerial accounting
- 640 Corporations I
- 641 Corporations II
- 644 Tax planning and current developments
- 645 Partnerships

- 661 Taxation of foreign investments
- 662 Taxation of multinational corporations

BUSINESS LAW

- 512 International business law
- 590 Studies in legal principles
- 666 Legal aspects of international marketing
- 670 Essentials of administrative law
- 685 Legal aspects of health administration
- 696 Legal and ethical implications in executive decision making

ECONOMICS

- 510 Mathematical economics
- 520 Econometrics
- 542 Comparative economic systems
- 611 Labor economics and labor relations
- 620 Advanced econometrics
- 621 Advanced macroanalysis
- 633 Advanced micro analysis
- 634 Advanced micro analysis II
- 641 Problems of economic development
- 660 International economics
- 666 Economics of liability
- 682 Macroeconomics
- 691 Managerial economics

FINANCE

- 530 Financial credit management
- 578 Financial planning
- 630 Essential of business finance
- 632 Advanced corporation finance
- 661 International finance
- 662 International financial management

GENERAL BUSINESS, MANAGEMENT AND ORGANIZATION

- 553 Case studies in small firm management
- 581 Health administration approaches and organizations
- 602 Personnel administration
- 650 Essentials of management
- 651 Behavioral and organizational systems
- 652 Management and administrative systems
- 653 Operations management
- 657 Corporate strategy
- 658 Business policies
- 659 Management of multinational enterprise
- 661 Management by objectives (MBO)
- 681 Essential of health care administration
- 691 Managerial economics

MANAGEMENT SCIENCE AND COMPUTER INFORMATION SYSTEMS

- 511 Methods for the improvement of quality and productivity
- 523 Data base management systems
- 524 Design of information systems
- 601 Applied regression analysis
- 602 Applied multivariate statistics
- 603 Design of experiments
- 607 Survey sampling
- 621 Management information systems
- 622 Small business computer applications
- 635 Implementation of computer information systems
- 661 Forecasting methods
- 663 Project management techniques
- 665 Operations planning and control

MARKETING

- 660 Foundations of marketing management
- 662 Advanced marketing management
- 665 International marketing
- 666 Legal aspects of international marketing

POLITICS AND PUBLIC AFFAIRS

- 524 Budget and financial management administration
- 647 Personnel administration
- 651 Productivity in the public sector

ELECTRICAL AND COMPUTER ENGINEERING

- 511 Software engineering
- 521 Computer operating systems
- 523 Introduction to filing
- 524 Simulation and design automation
- 623 Data base security and integrity
- 637 Robotics system design
- 651 Microcomputer-based design

Appendix IV

List of Journals and Periodicals Available
at UM Libraries

UNIVERSITY OF MIAMI SERIALS HOLDING LIST FOR I.E.

BELL JOURNAL OF ECONOMICS
BELL JOURNAL OF ECONOMICS (copy 2)
BELL JOURNAL OF ECONOMICS AND MANAGEMENT SCIENCE
BUSINESS HORIZONS
CALIFORNIA MANAGEMENT REVIEW
COMPUTERS AND INDUSTRIAL ENGINEERING
DECISION SCIENCES
ECONOMETRICA
ECONOMETRICA. (CUMULATIVE INDEX)
HARVARD BUSINESS REVIEW
HARVARD BUSINESS REVIEW (COPY 2)
HARVARD BUSINESS REVIEW. (CUMULATIVE INDEX)
I E E E SPECTRUM
I E: INDUSTRIAL ENGINEERING
I L O INFORMATION
I L O PUBLICATIONS
INDUSTRIAL AND LABOR RELATIONS REVIEW
INDUSTRIAL AND LABOR RELATIONS REVIEW. (COPY 2)
INDUSTRIAL AND LABOR REVIEW. (CUMULATIVE INDEX)
INDUSTRIAL ENGINEERING
INDUSTRIAL RELATIONS
INDUSTRIAL WEEK
INTERNATIONAL JOURNAL OF MINI AND MICROCOMPUTERS
JOURNAL OF BUSINESS
JOURNAL OF BUSINESS. (CUMULATIVE INDEX)

JOURNAL OF ECONOMETRICS
JOURNAL OF ECONOMETRICS. (CUMULATIVE INDEX)
JOURNAL OF ECONOMICS AND BUSINESS
JOURNAL OF ENVIRONMENTAL ECONOMICS AND MANAGEMENT
JOURNAL OF ENVIRONMENTAL ENGINEERING. (COPY 2)
JOURNAL OF INDUSTRIAL ECONOMICS
JOURNAL OF INDUSTRIAL RELATIONS
JOURNAL OF MARKETING
JOURNAL OF MARKETING. (CUMULATIVE INDEX)
JOURNAL OF MARKETING RESEARCH. (CUMULATIVE INDEX)
JOURNAL OF MONEY, CREDIT AND BANKING
JOURNAL OF OCCUPATIONAL PSYCHOLOGY
JOURNAL OF RETAILING
JOURNAL OF RETAILING. (CUMULATIVE INDEX)
JOURNAL OF SYSTEMS MANAGEMENT
JOURNAL OF SYSTEMS MANAGEMENT. (CUMULATIVE INDEX)
MANAGEMENT SCIENCE
MANAGEMENT SCIENCE. (CUMULATIVE INDEX)
MINI -MICRO SYSTEMS
MODERN MATERIALS HANDLING
O E C D OBSERVER
O E C D OBSERVER. (CUMULATIVE INDEX)
OPERATIONAL RESEARCH SOCIETY.
OPERATIONS RESEARCH. (CUMULATIVE INDEX)
OPERATIONS RESEARCH. (SUPPLEMENT)
OPERATIONS RESEARCH

OPERATIONS RESEARCH SOCIETY OF AMERICA.
OPERATIONS RESEARCH SOCIETY OF AMERICA. (ORSA/TIMS BULLETIN
OPERATIONS RESEARCH SOCIETY OF AMERICA. (TIMS/ORSA BULLETIN
PERSONNEL PSYCHOLOGY
PERSONNEL PSYCHOLOGY (CUMULATIVE INDEX)
RESEARCH MANAGEMENT
ROBOTICS TODAY
ROYAL STATISTICAL SOCIETY.
ROYAL STATISTICAL SOCIETY (JOURNAL SERIES A)
ROYAL STATISTICAL SOCIETY (JOURNAL SERIES B)
ROYAL STATISTICAL SOCIETY (JOURNAL SERIES C)
ROYAL STATISTICAL SOCIETY.
SLOAN MANAGEMENT REVIEW. (CUMULATIVE INDEX)
SMALL GROUP BEHAVIOR
SOCIO-ECONOMIC PLANNING SCIENCES
ACADEMY OF MANAGEMENT.
ACADEMY OF MANAGEMENT. (CUMULATIVE INDEX)
ACADEMY OF MANAGEMENT. (REVIEW)
AMERICAN ECONOMIC REVIEW
AMERICAN ECONOMIC REVIEW. (SUPPLEMENT)
AMERICAN STATISTICAL ASSOCIATION.
AMERICAN STATISTICAL ASSOCIATION. (CUMULATIVE INDEX)
AMERICAN STATISTICAL ASSOCIATION. (PUBLICATIONS)
AMERICAN STATISTICAL ASSOCIATION. (QUARTERLY PUBLICATIONS)
AMERICAN STATISTICIAN
AMERICAN STATISTICIAN. (CUMULATIVE INDEX)

JOURNAL OF ECONOMETRICS. (CUMULATIVE INDEX)
JOURNAL OF ECONOMICS AND BUSINESS
JOURNAL OF ENVIRONMENTALECONOMICS AND MANAGEMENT
JOURNAL OF ENVIRONMENTAL ENGINEERING. (COPY 2)
JOURNAL OF INDUSTRIAL ECONOMICS
JOURNAL OF INDUSTRIAL RELATIONS
JOURNAL OF MARKETING
JOURNAL OF MARKETING. (CUMULATIVE INDEX)
JOURNAL OF MARKETING RESEARCH
JOURNAL OF MARKETING RESEARCH. (CUMULATIVE INDEX)
JOURNAL OF MONEY, CREDIT AND BANKING
JOURNAL OF OCCUPATIONAL PSYCHOLOGY
JOURNAL OF RETAIL BANKING
JOURNAL OF RETAILING. (CUMULATIVE INDEX)
JOURNAL OF SYSTEMS MANAGEMENT
JOURNAL OF SYSTEMS MANAGEMENT. (CUMULATIVE INDEX)
MANAGEMENT SCIENCE
MANAGEMENT SCIENCE. (CUMULATIVE INDEX)
MINI - MICRO SYSTEMS
MODERN MATERIALS HANDLING

JOURNALS TO BE SEARCHED

(up to 20 years)

IIE

- ✓ 1. ~~AIEE~~ Transactions
- ✓ 2. Industrial Engineering
- o 3. International Journal of Production Research
- ✓ 4. IBM Systems Journal
- o 5. The Logistics and Transportation Review
- o 6. Naval Research Logistics Quarterly *SEE DOCUMENTS*
- ✓ 7. Operations Research
- ✓ 8. Operations [↑]Research ~~Quarterly~~ *SOCIETY. QUARTERLY*
- ✓ 9. Management Science
- ✓ 10. Interfaces
- ✓ 11. SIAM Review (SIAM - Society for Industrial & Applied Mathematics)
- ✓ 12. SIAM Journal ^{ON} ~~of~~ Applied Mathematics. *SOCIETY FOR INDUS. & APPL. MATH*
- ✓ 13. Journal of Regional Science
- 14. Journal of Farm Economics ✓ *AGRI. JNL. OF AGRI. ECON.*
- ✓ 15. Geographical Analysis
- ✓ 16. International Economic Review
- ✓ 17. Econometrica
- o 18. Journal of the American Institute of Planners
- ✓ 19. Mathematical Programming
- ✓ 20. Networks
- ✓ 21. Transportation Science
- ed 1965* 22. Productivity Measurement Review
- o 23. Manufacturing Productivity Frontiers
- o 24. Productivity Perspectives
- ✓ 25. Sloan Management Review
- ✓ 26. Harvard Business Review
- ✓ 27. California Management Review
- ✓ 28. American Economic Review
- ✓ 29. Review of Economics and Statistics
- ✓ 30. Public Administration Review
- ✓ 31. Administrative Science Quarterly
- ✓ 32. American Statistical Association Journal

JOURNALS TO BE SEARCHED

(up to 20 years)

- ✓ 33. The Conference Board Record *ACROSS THE BOARD*
- ✓ 34. Monthly Labor Review
- ? ✓ 35. Journal of American Statistical Association *Card is out to Mickey*
- 36. London and Cambridge Economic Bulletin
- ✓ 37. Management Review
- ✓ 38. The Economic Journal
- ✓ 39. Economic Record
- ✓ 40. Southern Economic Journal
- ✓ 41. Journal of Economic Literature
- ✓ 42. Review ~~in~~ ^{OF} Income and Wealth
- ✓ 43. Business Economics
- ✓ 44. Financial Executive
- § (1977) ○ 45. ^{U. OF} Michigan Business Review
- ✓ 46. Management Focus
- ✓ 47. Management Services
- u 48. Factory *became Modern manufact. died 1971*
- ✓ 49. Management Accounting
- ✓ 50. Organizational Dynamics
- ✓ 51. Business Horizons
- ✓ 52. The Academy of Management Review
- ✓ 53. Academy of Management, JOURNAL
- ✓ 54. Dissertation Abstracts
- 55. Management Records *NOT now being pub'd.*
- ✓ 56. Supervisory Management
- ✓ 57. Personnel
- ✓ 58. Sales ^{and Marketing} Management

OTHER SOURCES FOR INFORMATION RELATING TO

PRODUCTIVITY TOPICS

- ✓ 1. National Bureau of Economic Research (NBER)
- ✓ 2. National Industrial Conference Board (NICB)
- ✓ 3. International Labor Office *Selected*
- ✓ 4. U.S. Dept. of Labor, Bureau of Labor Statistics (BLS) *Comp.*
- ✓ 5. Organization for European Economic Co-operation (OEEC)
- ✓ 6. Organization for European Community Development (OECD) *Sel.*
- ✓ 7. U.S. Congress, Joint Economic Committee *Comp.*
- ✓ 8. U.S. Office of Management and Budget *Comp.*
- ✓ 9. U.S. Bureau of the Budget
- 0 10. Dept. of Employment Gazette - Great Britain Weekly Magazine,
British Government Publication
- ? 11. British Institute of Management Magazine *NOT IN ULRIC#*
- 12. King's Fund for Hospitals - National Health Service Publications
Edgeware Rd.
Near Westway
London, W 2

or

Regional Health Authorities
Management Services Division
Eastbourn Terr.
London W 2

REFERENCES FOR ERGONOMICS
AND BIO. XXX ENGINEERING

- ✓ ACATA ORTHOPAEDICS SCANDINAVICA
- ✓ ACATA PHYSIOLOGICA SCANDINAVICA
- ✓ ACCIDENT ANALYSIS AND PREVENTION
- ✓ ACOUSTICAL SOCIETY OF AMERICA JOURNAL
- ✓ ACTA BIO THEORTICA
- ✓ ADVANCES IN MARINE BIOLOGY
- ✓ AEROSPACE MEDICINE ^{AVIATION, SPACE, & ENVIRON. MED.}
- ✓ AEROSPACE SAFETY ^{FLYING SAFETY}
- ✓ AGING AND HUMAN DEVELOPMENT ^{INT. JNL. AGING & HUMAN DEV.}
- ✓ AIIE TRANSACTIONS ^{AM. INST. INDUSTR. ENG. CONT. BY IIE TRANS}
- ✓ AMERICAN INDUSTRIAL HYGIENE ASS. JOURNAL
- ✓ AMERICAN JOURNAL OF PHYSICAL ANTHROPOLOGY
- ✓ AMERICAN JOURNAL OF PHYSIOLOGY
- ✓ AMERICAN JOURNAL OF PSYCHOANALYSIS
- ✓ AMERICAN JOURNAL OF PSYCHOLOGY
- ✓ AMERICAN SCIENTIST
- ✓ AMERICAN VOCATIONAL JOURNAL ^{VOCED}
- ✓ ANNALS OF BIOMEDICAL ENGINEERING
- ✓ ANNALS OF HUMAN BIOLOGY
- ✓ ANNALS NEW YORK ACADEMY OF SCIENCE
- ✓ APPLIED ERGONOMICS
- ARBEITSPHYSIOLOGY
- ARTIFICIAL LIMBS
- ✓ ARMY RESEARCH AND DEVELOPMENT
- ✓ ATMOSPHERIC ENVIRONMENT
- AUSTRALIAN JOURNAL OF PHYSIOLOGY
- ✓ AUSTRALIAN JOURNAL OF PSYCHOLOGY
- ✓ BEHAVIOR RESEARCH METHODS AND INSTRUMENTATION ^{& COMPUTERS}
- BIODYNAMICS
- ✓ BIOTECHNOLOGY AND BIOENGINEERING
- ✓ BIOSYSTEMS
- ✓ BIOLOGICAL BULLETIN
- ✓ BIOPHYSICAL JOURNAL
- ✓ BIOPHYSICAL BIOENGINEERING AND MEDICAL INSTRUMENTATION
- ✓ BRAIN
- ✓ BRITISH JOURNAL OF INDUSTRIAL RELATIONS
- BRITISH JOURNAL OF PROTECTIVE PSYCHOLOGY AND TOXICOLOGY
- ✓ BULLETIN OF MATHEMATICAL BIOLOGY
- ✓ COLUMBIA HUMAN RIGHTS REVIEW ^(LAW)
- ✓ COMPUTERS AND BIOMEDICAL RESEARCH
- ✓ COMPUTERS AND INDUSTRIAL ENGINEERING
- ✓ COMPUTERS AND PEOPLE
- COMPUTERS AND HUMANITIES
- ✓ DHEW (US DEPT. OF HEALTH, EDUCATION AND WELFARE) ^{Compr}
- ✓ DISABLED U.S.A
- ✓ ELECTROENCEPHALOGRAPHY AND CLINICAL NEUROPHYSIOLOGY
- ENGINEERING CYBERNETICS
- ✓ ENGINEERING MATERIAL AND DESIGN
- ✓ ENVIRONMENT
- ENVIRONMENT AND CONTROL
- ✓ ENVIRONMENTAL SCIENCE AND TECHNOLOGY
- ✓ ERGONOMICS
- ✓ FEDERAL PROCEEDINGS
- ✓ FEDERAL REGISTER
- ✓ HERALD OF THE ACADEMY OF SCIENCE USSR

2811
21

- ✓ HUMAN BIOLOGY
- ✓ HUMAN DEVELOPMENT
- ✓ HUMAN FACTORS
- ✓ HUMAN RELATIONS
- ✓ IEEE BIOMEDICAL ENGINEERING TRANSACTIONS ON
- ILLUMINATING ENGINEERING LIGHTING DESIGN & APPL.
- ✓ INDUSTRIAL ENGINEERING
- INDUSTRIAL DESIGN MAG.
- INSTITUTIONAL MECHANICAL ENGINEERING LONDON PROCEEDINGS
- ✓ INTERNATIONAL JOURNAL OF ENGINEERING SCIENCE
- ✓ INTERNATIONAL JOURNAL OF ENVIRONMENTAL STUDIES
- INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH
- ✓ JAPANESE JOURNAL OF APPLIED PHYSICS
- ✓ JOURNAL OF ACOUSTICAL SOCIETY OF AMERICA
- ✓ JOURNAL OF ANATOMY
- ✓ JOURNAL OF ANALYTICAL PSYCHOLOGY
- ✓ JOURNAL OF APPLIED BEHAVIOR ANALYSIS
- ✓ JOURNAL OF APPLIED PSYCHOLOGY
- ✓ JOURNAL OF APPLIED PHYSIOLOGY
- JOURNAL OF AVIATION MEDICINE SPACE & ENVIRON MED.
- ✓ JOURNAL OF BIOMECHANICS
- ✓ JOURNAL OF BIOMEDICAL MATERIAL RESEARCH
- ✓ JOURNAL OF BONE AND JOINT SURGERY
- JOURNAL OF ENGINEERING PSYCHOLOGY
- ✓ JOURNAL OF ENGINEERING PHYSICS
- ✓ JOURNAL OF EXPERIMENTAL PSYCHOLOGY
- ✓ JOURNAL OF HUMAN EVOLUTION
- ✓ JOURNAL OF HUMANISTIC PSYCHOLOGY
- JOURNAL OF INDUSTRIAL ENGINEERING Now IEEE TRANS.
- JOURNAL OF INDUSTRIAL PHYSIOLOGY
- JOURNAL OF INDUSTRIAL PSYCHOLOGY
- ✓ JOURNAL OF MEDICAL ENGINEERING AND TECHNOLOGY
- JOURNAL OF OCCUPATIONAL MEDICINE
- ✓ JOURNAL OF PHYSIOLOGY
- ✓ JOURNAL OF PLANNING AND ENVIRONMENTAL LAW (LAW)
- ✓ JOURNAL OF SAFETY RESEARCH
- ✓ JOURNAL OF SPEECH AND HEARING DISORDERS
- ✓ JOURNAL OF THEORETICAL BIOLOGY
- ✓ LANCET
- ✓ MEDICAL AND BIOLOGICAL ENGINEERING
- ✓ MEDICAL JOURNAL AUSTRALIAN
- MEDICAL RESEARCH ENGINEERING
- ✓ NATURE

1977/78 -- ?

June '81

on order

cancelled

disc 1966

disc 1970

disc 1980

Int J of
Man-Machine
Studies

- ✓ NEW SCIENCE SCIENTIST
- ✓ OCCUPATIONAL HAZARDS
- ✓ OCCUPATIONAL HEALTH AND SAFETY
- ✓ PERCEPTUAL AND MOTOR SKILLS
- ✓ PHYSICAL THERAPY
- ✓ PHYSIOLOGICAL REVIEWS
- ✓ PROCEEDINGS ROYAL SOCIETY, S.B.
- PROSTHETICS AND ORTHOTICS CLINIC
- PROSTHETIC INST. MECH. ENGINEERING
- QUARTERLY JOURNAL OF EXPERIMENTAL PHYSIOLOGY
- ✓ REHABILITATION COUNSELING BULLETIN
- ✓ REHABILITATION LITERATURE
- REHABILITATION RECORD SEE DOCUMENTS
- ✓ REMOTE SENSING OF ENVIRONMENT
- ✓ RESEARCH QUARTERLY FOR EXERCISE & SPORT
- ✓ SCANDINAVIAN JOURNAL OF REHABILITATION MEDICAL
- ✓ SCIENTIFIC AMERICAN

THE JOURNAL OF METHODS-TIME MEASUREMENTS
WORK ENVIRONMENT-HEALTH

Appendix V

Faculty Curriculum Vitae

Appendix VI

Summary of Faculty Research
and Scholarly Activity

Oscar Adaniya

(Ph.D. Georgia Tech 1983)

Books: None

Juried or refereed publications:

1 Submitted

Conference Proceedings, Non-refereed Publications and Presentations

1983: 1
1982: 2
1981: 2
1980: 1

Supervisory Role:

Supervised M.S. Projects

Shihab Asfour

Publications

Books, Monographs and Manuals:

1985: 6 - Articles in books
1984: 2 - Articles in books

Refereed Journal Articles:

1985: 1
1984: 1
1983: 3
1982: 1
1980: 1

Proceedings Articles:

1985: 5
1984: 6
1983: 2
1982: 2
1981: 1
1980: 1
1979: 1
1978: 2

Shihab Asfour
Publications

Continued

Presentations:

1984: 3
1983: 1
1981: 1

Master's Thesis:

1983: 2
In progress: 3

Ph.D. Dissertations

In progress: 3

Editorial:

Refereed papers for the Human Factors Journal and Computers and Industrial Engineering Journal. Reviewed "Human Factors in Engineering Design" by McCormick & Sanders for McGraw-Hill Company.

Nourredine Boubekri

Books, Monographs and Manuals:

1985: 1

Juried or Referred Journal Articles:

1985: 1

Other Publications:

1985: 4
1984: 1

Editorial

None

Thesis:

None but directed several student projects

Keebom Kang

(Ph.D. Purdue, 1984)

Books, Monographs or Manuals: None

Juried or Refereed Journals:

1985: Two in Preparation

Conference Proceedings and other Publications:

1984: 1

1983: 3

Editorial:

Referee for Simulation, IEEE Proceedings

Presentations:

1985: 2

Graduate Supervisory Role:

Member Ph.D. Committee

Tarek M. Khalil

(Ph.D. Texas Tech, 1969)

Books, Monographs, Manuals:

1985: 4 (contributions to books, in press)

1984: 1

1983: 1 (editor of a project hope meeting proceeding)

1982: 1 " " " " " "

1981: 1

1980:

Juried or Refereed Journal Articles:

1985: 1 + 1 accepted + 3 (submitted)

1984: 1

1983:

1982: 2

1981: 3

Conference Proceedings and other Publications:

1985: 4 accepted

1984: 8

1983: 3

1982: 4

1981: 2

Tarek M. Khalil
Continued

Editorial:

Editor special issue (HFS), McGraw Hill Book Co, Int'l Journal of Prod. Res.
Simulation, Computers and Industrial Engineering, Interfaces

Presentations:

Over 60 presentations over the past 5 years

Supervisory Role:

Post Doctoral: 2
Doctoral Level: 4 in progress
2 previous

M.S. Tehesis: 4 in progress
13 previous

M.S. Research Projects: over 15 M.S. projects

C. N. Kurucz

(Ph.D. Suny Buffalo, 1969)

Books and Monographs:

1982: 1

Juried Refereed Journal Articles:

1983: 1
1977: 2
1976: 1

Conference Proceedings and other Publications:

1980: 1
1977: 3
1976: 2

Editorial:

Journal of Computers and Operations Research

C. N. Kurucz
(Ph.D. Suny Buffalo, 1969)
Continued

Supervisory Role:

2 Ph.D.'s over 15 M.S. Students

J. Moder
(Ph.D. North Western 1950)

Books: Monographs, Manuals

1984-85: 1 Monograph in Preparation
1983: 1 (3rd edition)
1982: 2
1981: 2
1978: 1
1977: 1 (Handbook)

Juried or Refereed Publications

1980: 2

R. Rodriguez

(Ph.D. Georgia Tech 1983)

Books: None

Juried or Refereed Publications:

2 Submitted 1 in Preparation

Other Publications:

1977: 1
1974: 1
1985: 1 2 Submitted

Supervisory Role:

Supervised several M.S. Thesis and Students Projects

David J. Sumanth
(Ph.D., IIT 1979)

Books, Monographs, Manuals:

1984-85: 1
1983-84: 2
1981-82: 3
1980-81: 1

Juried or Refereed Publications:

1984-85: 1
1983-84: 1

Conf. Papers and Other Research Reports:

1984-85: 2
1983-84: 1
1982-83: 1
1981-82: 5
1980-81: 5
1979-80: 3

M.S. Thesis

1981-85: 1
1983-84: 1

Ph.D. Thesis

1984-85: 1
1983-84: 1

M.S. Research Projects

1983-84: 8
1982-83: 3
1981-82: 3
1980-81: 4
1979-80: 1

Earl L. Wiener
(Ph.D., Ohio State U., 1961)

Book, Monographs and Manuals:

1984: 1
1982: 1

Juried or Refereed Publications:

1984-85: 2
1983: 1
1982: 1
1981: 1

Earl L. Wiener
(Ph.D., Ohio State U. 1961)
Continued

Conference Proceedings and other Publications:

1984-85: 1
1983: 2
1981: 1

Editorial:

IIE Transactions, Journal of Safety Research, Accident Analysis and Prevention, Human Factors Society Chairman of Publication Committee and Managing Editor

Presentations:

Many Presentations to Local and National Groups Over the Past 5 years.

Supervisory Role:

Supervised both Ph.D. and M.S. Students

Appendix VII

Incremental Cost/Revenue Analysis

Ph.D. Program in Industrial Engineering Dept.

Expected Student Population

<u>Fiscal Year</u>	<u>New Students</u> +	<u>Old Students</u>	=	<u>Total Students</u>	-	<u>Graduating Students</u>	=	<u>Year-end Students</u>
June '85 - May '86	5	0		5		0		5
June '86 - May '87	5	5		10		0		10
June '87 - May '88	6	10		16		2		14
June '88 - May '89	8	14		22		4		18
June '89 - May '90	8	18		26		4		20

Expected Increases in Faculty*

<u>Fiscal Year</u>	<u># Faculty Added</u>	<u>Total Cumulative Faculty Added</u>	<u>Faculty Cost</u>
June '85 - May '86	0	0	0
June '86 - May '87	0	0	0
June '87 - May '88	0	0	0
June '88 - May '89	1	1	\$32,000
June '89 - May '90	0	1	\$32,000

Expected Increases in Teaching Assistants (TA's)

<u>Fiscal Year</u>	<u># TA's Added</u>	<u>Total Cumulative TA's Needed</u>	<u>TA Cost</u>
June '85 - May '86	2	2	\$ 22,000
June '86 - May '87	1	3	\$ 33,000
June '87 - May '88	1	4	\$ 44,000
June '88 - May '89	0	4	\$ 44,000
June '89 - May '90	0	4	\$ 44,000

*Note: The relief required for faculty will be covered by TA's.

Grants & Contracts received 1975-76 Annual Report

<u>Department</u>	<u>No. of Faculty*</u>	<u>Contracted Research Received</u>	<u>\$/Faculty</u>
AAEP (Architecture)	33	\$ 92,934	\$ 2,806
Biomedical Engr.	2	38,550	19,275
Civil Engr.	10	93,740	9,374
Electrical Engr.	9	45,075	5,008
Industrial Engr.	2	67,445	33,723
Mechanical Engr.	11	995,961	90,542

1976-77 Annual Report

AAEP (Architecture)	28	159,385	5,692
Biomedical Engr.	2	13,000	6,500
Civil Engr.	10	328,005	32,800
Electrical Engr.	9	22,654	2,517
Industrial Engr.	2	52,778	26,389
Mechanical Engr.	12	505,045	42,087

* persons with teaching contracts (not FTE)

SUBMITTED SPONSORED PROJECTS
1978 - 1984
Industrial Engineering

PRINCIPAL INVESTIGATOR	TITLE OF PROJECT	AGENCY NAME	BUDGET	YEAR
Dr. Sumanth	Presidential Young Investigator Award	6/27/83 to NSF	\$ 125,000 TOT.	1984
Drs. Khalil and Asfour	Effects of Environmental Conditions and Circadian Rhythm Disruption of Human Performance	11/30/82 DOD	\$ 229,596 TOT.	
Drs. Khalil and Asfour	Rehabilitation Engineering Center - Improving Rehabilitation for Low Back Pain	5/2/83	\$ 81,666 (over 2,000,000) TOT	
Dr. Rosomoff (School of Medicine)	Low Back Pain Assessment	6/23/82 Social Sec. Adm.	\$ 150,000 TOT.	
Dr. Sumanth	Evaluation of Robot Performance	11/30/82 DOD	78,198 TOT.	
Dr. Sumanth	Productivity Planning in Companies	8/6/81 NSF New Proposal	\$ 101,702 TOT.	
Dr. Asfour	Determination of Climatological Conditions in a Typical Dry Food Warehouse	5/17/82 American Can Co.	3,525 TOT.	1982
Dr. Adaniya	Research Initiation Grant Proposal-Oscar Adaniya	5/18/82	5,000 TOT.	
Prof. Kromp	Initiation of Energy Conservation and Management Programs for Electronics, Garment & Shoe Industries South Florida Area	8/21/80 Governor's Energy Office-State of Florida	12,890 TOT.	

SUBMITTED SPONSORED PROJECTS (CONT'D.)

1978 - 1984

Industrial Engineering

PRINCIPAL INVESTIGATOR	TITLE OF PROJECT	AGENCY NAME	BUDGET
Prof. Sani	"Hands-On" Experience in Operating and Programming of Numerically Controlled Machine Tools	2/26/81 NSF	\$ 39,981 TOT.
Dr. Khalil/ Dr. Greco	Vibration Effects on Muscular Performance	2/26/81 U.S. Army	\$ 77,403 TOT.
Dr. Khalil	Study for Vibration Effects on Muscular Performance	9/8/78 U.S. Army Aviation Research Lab. (new project)	\$ 94,564 TOT.
Dr. Khalil	Occupation Safety and Health Educational Resource Center	10/28/78 NIOSH	\$5,358,523 TOT
Prof. Kromp	Pre-Freshman Enrichment Program in Eng. for Minorities	11/3/78 Dept. of Energy (New \$)	\$ 24,480 TOT.
Prof. Kromp	Electro-Cracking Injector for Improving Gas Mileage	5/24/79 DOE (New \$)	\$ 49,985 TOT.
Dr. Kurucz	National Crash Severity Study	5/11/79 (Renewal)	\$224,742 TOT.

Ph.D. Program in Industrial Engineering
Incremental Cost/Revenue Analysis

Fiscal Year

	1985-'86	1986-'87	1987-'88	1988-'89	1989-'90
<u>INCREMENTAL COSTS:</u>					
Additional Faculty	\$ -	-	-	\$ 32,000	\$ 32,000
Additional TA's	\$ 22,000	33,000	44,000	44,000	44,000
Additional Lab. Equipment	\$ 3,000	6,000	10,000	5,000	5,000
Library Research (Addl.)	\$ 500	1,000	1,000	1,500	1,500
Space (additional)	\$ -	-	-	-	-
Additional Supplies for Labs & Offices	\$ 500	1,000	1,500	1,500	1,500
Additional Travel for presentations, research contacts, etc.	1,000	2,000	2,000	2,500	3,000
Secretary (1/2 time)	\$ -	-	-	-	10,000

Total Incremental Costs	\$ 27,000	43,000	58,500	86,500	97,000
-------------------------	-----------	--------	--------	--------	--------

INCREMENTAL REVENUE:

Tuition*	\$ 22,500	45,000	72,000	81,000	99,000
Net Marginal Revenue	\$ (4,500)	2,000	13,500	(5,500)	2,000
Cumulative Marginal Revenue	\$ (4,500)	(2,500)	11,000	5,500	7,500

*@ \$300/credit hour for 15 credit hours/fiscal year. The "year-end student" count is used in this computation.

Research and other Funding Sources for Participating Faculty
(Rounded Figures)

	78	79	80	81	82	83	84-85	Source	PI's
40,000 (end of a 3 yr contract)								NIOSH	Khalil
62,000	54,000								
		20,000		20,000				DOT	Kurucz, Joint with CE Sumanth
70,000								NSF	
	4,200	3,100		3,200	3,200	4,000	5,000	USAARL	Khalil/Greco
						4,000		Burger King	Khalil/Kromp
					6,000	4,000		Frank B. Hall	Kromp/Khalil
				3,700				American Can Co.	Asfour
				4,000				NIH	Asfour
						50,000 (including equipment)		IBM	Einspruch Kromp
					55,000	82,000	88,000	Medical Research Applications	Khalil/Asfour
					88,000	98,000	103,000	NASA	Wiener (M.S.)
223,000				57,550	143,500	150,000		EPA	Phaffenberger (EPH)
							8,500	IBM	Sumanth/Boubekri
							6,200	DOL	Khalil
57,000	70,000					97,000	99,000	State of Florida	Moder (M.S.) Subsidy

A Ph.D. PROGRAM IN ERGONOMICS

The faculty members of the Department of Industrial Engineering request the University's approval to establish the Ph.D. Program in Ergonomics with formal participation of the Departments of Management Science and Neurological Surgery. This request is predicated on the following important bases:

- 1) The Ergonomics area is interdisciplinary in nature. It is closely allied with the fields of Psychology, Physiology, Anatomy, Epidemiology and Engineering. The University of Miami offerings in these areas and in collateral fields are extremely powerful.
- 2) Existing faculty members with very strong academic credentials, and outstanding national and international reputation.
- 3) The Department has a demonstrated capability to initiate such a program.

Existing Faculty*

The faculty members involved in the Ergonomics Program are: Dr. T.M. Khalil (IEN), Dr. S.S. Asfour (IEN), Dr. D. Sumanth (IEN), Vincent Omachonu (IEN), Dr. M. Goldberg (Neurological Surgery), Dr. E. Wiener (MAS/IEN), Dr. C. Kurucz (MAS/IEN), Dr. J. Moder (MAS/IEN, emeritus), Dr. M. Rhodes (adjunct), and Dr. C. Pffafenberger (adjunct)

Drs. Khalil, Asfour, Goldberg, Wiener, Sumanth, and Omachonu are primary faculty and are capable of supervising Ph.D. candidates. One faculty member is on a terminal contract and his position will be filled with a candidate qualified in this field. Drs. Moder, Kurucz, Rhodes, and Pffafenberger are valuable resources for teaching courses and participating in supervisory committees.

Dr. Khalil is an internationally recognized authority in Ergonomics. He received several major professional awards for his contribution to the field; these include:

- 1) The Human Factors Society's Jack A. Kraft Award "For Significant Efforts to Extend the Applications of Human Factors to new or Unique Areas of Endeavor."
- 2) The First Institute of Industrial Engineers Division Award "For Significant Accomplishments in the Theory and Applications of Ergonomics".
- 3) The Institute of Industrial Engineers Fellow Award "For Professional Leadership and Outstanding Contributions to Industrial Engineering".

*Department of Management Science and Department of Neurological Surgery note of formal participation in the program are given in Exhibit 4.

In the academic year 86-87 alone, Dr. Khalil has authored or co-authored with colleagues and graduate students four papers in refereed journals, four papers in published books, two papers in edited journals and five papers in conference proceedings. This reflects the level of his commitment and involvement in graduate education and research. He is currently supervising the dissertation of two Ph.D. candidates under the Graduate School's interdepartmental Ph.D. program. Both expect to defend their dissertations this semester.

Dr. Asfour is an Associate Professor in the Department of Industrial Engineering. He is nationally recognized in the field of Ergonomics and is a founding member of the International Ergonomics Foundation. He is the Conference Chairman of the Third International Conference on Industrial Ergonomics and Safety to be held in Miami, Florida in 1987. He is the sole editor of selected conference papers to be published by North Holland in June 1987. Dr. Asfour is an excellent teacher and an outstanding scholar. In the past five years alone he has published thirteen papers in refereed journals, 18 papers in published books or monographs and more than 27 papers in conference proceedings. He currently chairs two Ph.D. Committees under the Interdepartmental Ph.D. Program. One of the candidates will be defending his Dissertation this semester.

Dr. Myron Goldberg is a Research Assistant Professor in the Department of Neurological Surgery. Dr. Goldberg serves as the clinical supervisor of the Ergonomics Division of the Comprehensive Pain and Rehabilitation Center. The CPRC is an Internationally recognized health care delivery facility with outstanding reputation for its unique approaches and the implementation of cutting edge research findings into the delivery of care to patients with back pain and musculoskeletal injuries. The Center's work has been featured in Life Magazine, CBS News, The New Yorker, The Miami Herald, People's Magazine and many others.

The CPRC is truly an interdisciplinary organization with about 100 professionals involved in its activities. These include M.D.'s, Psychologists (Ph.D.'s), Physical, Occupational and Vocational Therapists and Nursing. The Ergonomics Division is the main research and application area of the Center's activities. This Division is directed by Drs. Khalil and Asfour and manned by Industrial Engineering graduate students. Dr. Goldberg, as the clinical supervisor, interacts daily with IEN graduate students and supervises many of their projects. He works very closely with Dr. Khalil and Asfour and is a member of graduate committees of at least four IEN graduate students. Dr. Goldberg has published excellent papers in refereed journals and he is just being submitted for membership to a graduate faculty

status. He is certainly capable, willing and indeed is a valuable source to graduate dissertation committees in the Department of Industrial Engineering.

It should be noted here that several other extremely well qualified faculty members in the Comprehensive Pain and Rehabilitation Center do serve on graduate committees of IEN students. These include Dr. Hubert Rosomoff and Dr. David Fishbain. They provide valuable resources to research and graduate work in Ergonomics that have not been listed in the documentation provided with the initial Ph.D. Proposal.

Dr. Earl Wiener, Professor of Management Science and Industrial Engineering is a nationally and internationally recognized authority in Human Factors/Ergonomics. Dr. Wiener has served as Chairman of Publications and managing editor of the Human Factors Society from 1983-1987. He is a member of the executive board of the Society and is a fellow of the Society. Dr. Wiener has been a member of the Industrial Engineering Faculty since 1962. He served on the editorial board of the Industrial Engineering Transactions for many years. He joined the School of Business Administration together with other members of the Department of Industrial Engineering when the University was considering the abolishment of the School of Engineering in the seventies. Dr. Wiener continued his research in the area of human factors which is closely associated with the intellectual base existent in the Department of Industrial Engineering. Together with Drs. Moder and Kurucz they continued to teach IEN students, participate in accreditation efforts of the College of Engineering and provide valuable academic support to IEN students.

Drs. Moder, Kurucz and Wiener still teach required undergraduate and graduate courses in the Industrial Engineering curriculum. They participate in graduate research committees of Industrial Engineering students and are involved in professional activities of the Institute of Industrial Engineers, The Human Factors Society and the Department of Industrial Engineering. Their involvement is by no means considered "cosmetic". They are part of the intellectual and resource base that strongly influence our students.

With the establishment of a Ph.D. Program in Ergonomics, Dr. Wiener will be in a position to chair or participate in Ph.D. dissertation committees of graduate students. He will have access to students that are well prepared in the same field and areas of interest that he has. This is a condition that does not exist in his current primary appointment department. Although Drs. Moder and Kurucz do not teach Ergonomics courses, their knowledge and teaching in the statistics area is an essential ingredient in supporting the experimental research work in Ergonomics. They are valuable resources for graduate committee work.

Dr. David Sumanth is an Associate Professor in the department. He is nationally recognized in the area of Productivity Research. He just completed the editing of a book published by Elsevier Book Company based on refereed papers of the International Conference on Productivity Research, which he chaired. Dr. Sumanth has published another leading book on Productivity Engineering and Management. One of his major areas of interest is white collar productivity. Major productivity improvement effort is based on Ergonomics research and applications.

Vincent Omachonu who obtained a M.S. degree from Columbia besides his M.S. degree from Miami, taught graduate and undergraduate Human Factors courses at the Polytechnic University in New York for four years. He established the Ergonomics Laboratory for the University and supervised both graduate and undergraduate student projects in this area. He has completed the writing of his dissertation and will defend it in New York this March. His education, training, and academic experience certainly more than qualify him to contribute to our Ph.D. Program in the very near future. He wrote three research proposals since he joined our faculty last semester. He also has two papers accepted for publication in a book to appear soon.

A new position will become available in the near future. Recruitment for a new faculty member to replace him has already begun.

Consultant's Report

The external consultant's report (Exhibit 3) made by Dr. Tillman, a chairman of a well established Ph.D.- granting Department for more than 20 years, and Dr. Chaffin, the best recognized Ergonomics researcher in the U.S. and former Chairman of the IE Department at the University of Michigan, clearly establishes the Department's ability to grant the Ph.D. degree in Ergonomics. A copy of their findings related to the Ergonomics concentration is enclosed herewith for convenience. The graduate council committees upon exhaustive review of the program and its supporting components ascertained that the proposed program in this concentration is indeed a strong and viable program to be worthy of immediate implementation.

Research Support

The Department of Industrial Engineering is an undergraduate and graduate degree granting department. It enrolls about 170 undergraduate students and over 65 graduate students. Some of those are enrolled in the highly successful MSIE/MBA Weekend Program.

Traditionally, support for the department was not derived from research sources. The department receives state funding for its undergraduate Manufacturing Option Program and tuition revenues from the highly successful MSIE/MBA weekend program.

The department is changing its focus to strengthen faculty research and increase scholarly output. Remarkable progress has been achieved in a short period of time. Outside sources of support this academic year included direct grants received from companies and research agencies (Exhibit 1) as well as program support for the Ergonomics Division of the CPRC (Exhibit 2). These outside sources have been adequate for the support of twelve graduate students in the Ergonomics area of concentration.

Program support in Ergonomics in the Comprehensive Pain and Rehabilitation Center (CPRC) is provided for unique collaborative research and application effort in the rehabilitation of musculoskeletal injuries and low back pain. This is a continuing activity of the Ergonomics Division, a major division of the center. The division is funded annually at the level of \$150,000 and is considered a mainstream activity rather than a single task oriented research activity. The Ergonomics Division is managed by Dr. Khalil as Division Chief, Dr. Asfour as Assistant Chief, and Dr. Goldberg as a clinical supervisor. The division offices and laboratories are located in Southshore Hospital on Miami Beach. Interdisciplinary research work conducted in these laboratories has led to many publications in refereed journals, and national and international conference proceedings. Published work has attracted international recognition to the center's activity. Two master's theses have been completed and one Ph.D. dissertation is in its final stages of completion this semester as a result of research work within the division. Drs. Khalil and Asfour are supported 25% each for their research activities within the division. Dr. Goldberg is a full-time research assistant professor with his major appointment in the Department of Neurological Surgery and secondary appointment in Industrial Engineering.

Dr. Wiener, a valued colleague in the Ergonomics field and a participant in our effort, has an outside contract with NASA at the level of \$100,000 this year. Even though Dr. Wiener's primary appointment is in a different department, in the future he is expected to be able to supervise and/or support a graduate student pursuing a Ph.D. in the field. It should be noted that Dr. Wiener's initial appointment in the University was in the Industrial Engineering Department. He continues to hold the rank of a professor in the department as a secondary appointment. He teaches valuable graduate experimental statistics courses that are required of students working on a Ph.D. in Ergonomics.

Graduate School Endorsement

The Graduate School has approved the Ph.D. program in Ergonomics and notification have been sent to the Faculty Senate (Exhibit 5).

Recomendations

The existing strength in faculty and available resources indicate that a Ph.D. program in Ergonomics is indeed viable. Based on all these facts provided, the faculty of the Department of Industrial Engineering with the formal particiaption of the Department of Neurological Surgery and Management Science urges the adoption of the following:

Establish a Ph.D. Program in Ergonomics. Admission to the Program will be limited to three new students per year for the first three years.

ERGONOMICS TRACK

The ergonomics track of the Ph.D. Program will not only prepare the students in the recognized IE subjects, but also will provide them with in depth knowledge in the methodologies and concepts of ergonomics. This track will provide students with a strong background that will enable them to conduct advanced research in Occupational Biomechanics, Work Physiology, Prevention and Rehabilitation of Musculoskeletal Injuries.

CURRICULUM STRUCTURE

Students enrolling in the Ergonomics track of the Ph.D. Program are expected to have completed the following courses (or equivalent) during their Master's Degree Program.

IEN Core Courses

IEN 612 Design of Experiments
IEN 641 Applied Operations Research
IEN 657 Ergonomics & Occupational Biomechanics
IEN 660 Productivity Measurement & Evaluation
IEN 547 Computer Simulation Systems
or IEN 647 Advanced Computer Simulation Systems

Ergonomics Concentration

IEN 557 Man-Machine Systems
IEN 558 Industrial Hygiene
IEN 659 Work Physiology

Each Ph.D. student will be required to take at least 24 credits out of the following list of Courses:

IEN 551 Accident Prevention Systems
IEN 655 Advanced Seminar in Ergonomics
BME 501 Unified Medical Sciences I
BME 505 Intro to Biomedical Instrumentation
BME 580 Biomedical Instrumentation
BME 613 Application of Computers in Medicine
EPH 621 Chronic Disease Epidemiology
MAS 606 Nonparametric Statistics
PSY 606 Multiple Regression & Multivariate Statistics
PSY 614 Sensory Processes

The student's Advisory Committee may recommend additional courses to suit the student's background and program objectives.

EXHIBIT 1

GRANTS RECEIVED SINCE THE START OF FISCAL YEAR 86-87

(Round Figures)

American Can	\$7,000	Asfour
Ryder System	7,500	Adaniya
Allen Morris	6,000	Sumanth
Interamerican Bank	4,300	Khalil
Burger King	6,000	Khalil
Frank B. Hall	5,000	Khalil
Research Support	5,000	Omachonu
UMTA	73,000	Sumanth
FP&L	4,800	Kang
	<u>\$118,600</u>	

* Dr. Wiener, a member of the faculty of the Department of Management Science, has a secondary appointment in Industrial Engineering. He is a member of the Ph.D. Program Committee and is qualified and interested in the supervision of IEN Ph.D. dissertations. Dr. Wiener is sponsored by NASA at the level of \$100,000.

EXHIBIT 2

PROGRAM SUPPORT
ERGONOMICS IN REHABILITATION
AND LOW BACK PAIN

Comprehensive Pain and Rehabilitation Center
(June 1, 1986 - May 31, 1987)

<u>Name</u>	<u>\$(round figures)</u>
T. M. Khalil, Ph.D.	17,000
S. Asfour, Ph.D.	17,000
M. Goldberg, Ph.D.* (Estimated level of direct involvement)	26,000 (1/2 time @52,000)
E. Moty	36,000 (Ph. D. Candidate)
E. Bon	30,000 (M.S.I.E. Candidate)
S. Waly Candidate)	13,000 (M.S.I.E., Ph.D.)
A. Zaki	13,000 (M.S.I.E. Candidate)
L. Melean	8,100 (M.S.I.E., potential Ph. D. candidate)
	<hr/> 162,000

* Dr. Goldberg is a research Assistant Professor in the Department of Neurological Surgery. He is the clinical supervisor of the Ergonomics Division, CPRC. He spends at least 1/2 time in research applications and supervision of graduate students' work in Ergonomics.

EXHIBIT 3

OUTSIDE CONSULTANTS REPORT

Ergonomics

This proposed program emphasizes the development of the physiological and biomechanical knowledge necessary to identify, evaluate and manage problems associated with the rehabilitation and return to work of chronic pain patients.

1. The research experience and training of Drs. Khalil and Ashford provide the ability to offer effective 3rd level, special topics courses in the methodological areas of work physiology and occupational biomechanics, and is a major positive factor in recommending this program.

2. The department has established a tradition of requiring students to take courses in supporting disciplines, and no structural barriers appear to exist in such cross-discipline education. The faculty were knowledgeable of appropriate graduate courses in psychology, biomedical engineering and epidemiology which would provide the intellectual breadth necessary to perform contemporary ergonomics research. The secondary appointments of Drs. Wiener and Goldberg further assist in this regard.

3. The extensive and scholarly research and experience of Drs. Khalil and Asford is highly appropriate and supportive of the proposed ergonomics Ph.D. program. They provide the intellectual "critical mass" necessary to assure that the students would receive adequate, timely guidance and intellectual stimulation. Their close research collaboration with Dr. Goldberg, who has a neural-behavioral background, will further facilitate the establishment of a viable Ph.D. educational environment.

4. Present external funding for ergonomics is barely adequate in quantity to support 3 to 4 Ph.D. students each year. As a reference, Ergonomics Ph.D. graduates from Michigan require approximately three years post masters, and an average of \$150,000 each (ie, salaries, laboratory equipment, computer time, supplies, subject fees, etc.). To expand the program at Miami will require additional internal student salary support (TA's and tuition grants) and external funds (see note 6 and below).

5. At present the IE faculty instructional load of between two to three courses/term is too heavy to permit the faculty to recruit and develop a Ph.D. program in ergonomics. No more than 2 courses/term should be

permitted if a faculty member is expected to work with Ph.D. students. Further, if that faculty member has any significant sponsored research funds supporting himself or a Ph.D. student's research, he/she should be released from instruction commensurate with normal guidelines (ie, 20% salary support or 3 Ph.D. students being advised releases a person from teaching a course).

6. The present application of ergonomics by this faculty is to rehabilitation and occupational health. This is unique and important. NIOSH has stated a need for more engineers educated in this field and has special funding initiatives in research and training to promote this area. Federal and state EEOC and rehabilitation regulations are strong incentives for companies and their foundations to support this effort. At best, only five (Michigan, Texas Tech, Auburn, Ohio State and VPI) have IE programs capable of the types of research proposed by this faculty in ergonomics, though many other IE programs are contemplating such an emphasis (as seen at Michigan by the strong demand for Ph.D. graduates in this field).

7. The present space and equipment available in both the School of Engineering and Comprehensive Pain and Rehabilitation Institute is adequate to support at most 5 Ph.D. students in ergonomics, but some incidental costs should be expected (eg, general supplies, office space, TA support etc.). One issue that will arise as the program grows in size is the adequacy of technical support to develop special equipment and software. A dedicated (1/2 time) qualified technician will be needed if more than a few Ph.D. students are expected in this highly experimental area.

In Summary, the ergonomics research program applied to rehabilitation

and occupational health planning in industry is well developed and could support a few Ph.D. students with small incremental costs (some faculty released time, supplies, TA appointments, etc.). A viable program should involve a minimum of five Ph.D. students in ergonomics. Several MS students we met indicated that with some financial aid they would continue their studies toward a Ph.D. in ergonomics. To allow the program to expand beyond five students will require, 1) the addition of a qualified faculty member in ergonomics, 2) a significant increase in external research/training funds, and a proportional increase in TA, supplies space, and technician support.

EXHIBIT 4

Letters of notification of formal support and participation
in the Ph.D. program in Ergonomics.